



Human Computer Interaction

Final Report: Invenit Projectum

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# 1. Project Overview

- **Project Name:** Wanderlust
- **Value Proposition:** A never-ending journey
- **Group Name:** Invenit Projectum

The goal of this report is to provide an in-depth analysis of the development process of our project, carried out as part of the Human-Computer Interaction [02JSKOV] course at Politecnico di Torino during the 2024/2025 academic year.

The group, named **Invenit Projectum**, consists of

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We will carry out a reflective analysis of our journey, focusing on the insights gained, the challenges overcome, and the achievements accomplished. Our aim is not merely to describe the work done, but to delve deeply into our shared learning experience and highlight what we will take away from our participation in the aforementioned course.

## 2. Problem/Solution Overview

Our project, developed over the course of five months, focused on the theme of human-computer interaction, particularly in the context of outdoor activities and exploration. Starting with the idea of creating engaging experiences to encourage users to discover the world in innovative ways, we explored how **Human-Computer Interaction** can enhance user engagement and make interactions more intuitive and enjoyable. This reflection led to the design and development of a prototype application aimed at turning these ideas into a practical and enjoyable experience.

Each stage of the project, from initial concepts to the final implementation, will be detailed to highlight the motivations behind our decisions and the path we chose to take.

## 3. Needfinding

### 3.1 Domain Description

Our project is centered on the domain of "**Outdoor Activities for Discovering the World**". Initially, we debated various possibilities, including **cultural heritage** and **local cuisine**, as ways to engage with and explore the world. However, a team member's strong interest in climbing inspired us to redirect our focus toward **outdoor activities**.

It became evident that outdoor activities go beyond mere physical exercise; they offer unique chances for **adventure** and **discovery**. These activities allow individuals to immerse themselves in nature, interact with their surroundings, and experience the world in an active and dynamic manner. This insight solidified outdoor activities as the ideal domain for our project.

## 3.2 Interviews

### 3.2.1 Participants

Our project involved a carefully selected group of participants to ensure diverse yet relevant perspectives on outdoor activities.

We identified two primary categories of users: **immediate users** and **extreme users**. Immediate users included **outdoor runners** who run at least two to three times a month, as well as cyclists who cycle at least twice a month. Extreme users were represented by domain experts, such as **professional runners** with extensive experience in outdoor running. We also included **competitive runners** and **cyclists**, whose advanced skills and frequent engagement provided valuable insights into the challenges faced by highly active individuals.

In total, eight interviews were conducted with participants. All interviewees were male, aged between 20 and 40 years. This demographic was chosen to reflect a group of outdoor enthusiasts who actively engage with the kinds of activities relevant to our project.

Participants were recruited through a combination of personal networks and targeted outreach. Recruitment efforts focused on locations where outdoor activities are commonly practiced, such as popular cycling routes and city parks. This approach ensured that our participants were representative of the user base we aim to serve, allowing us to gather meaningful and actionable insights.

### 3.2.2 Methodology and Execution

For the interview and recruitment process, three key locations in Turin were selected based on their frequent use by cyclists and runners for training activities. The chosen locations are “**Parco del Valentino**”, “**Parco Ruffini**”, and “**Parco Sangone**”.

The interviewees were provided with a consent form for participation in the interview, which clearly outlines the purpose of the interview and the conditions of data collection. The document is structured into five key sections:

1. **Recording and Data Collection** – It is explained that the interview may be recorded, and interviewers may take notes during the process.
2. **Purpose and Data Usage** – The objective of the interview is outlined, along with a clarification of how the collected data will be used.
3. **Confidentiality** – It is stated that the participant's sensitive data will not be disclosed without their explicit consent.

4. **Voluntary Participation** – The voluntary nature of participation is emphasized, and interviewees are informed of their right to withdraw at any time. In such cases, all collected data and recordings will be immediately destroyed.
5. **Consent** – A formal section where participants provide their explicit consent to take part in the interview and sign the document.

The questions are divided into contexts and areas and include only the following:

- **Introduction and general context**
  - Why did you start running/cycling?
  - Why did you choose running instead of cycling?
- **Pros and cons**
  - Tell me 3 positive and 3 negative aspects of running/cycling
- **Reflection on personal experience**
  - Do you remember the first time you started running/cycling?
  - How did you feel?
- **Recent experience**
  - On a scale from 1 to 5 (where 1 is very boring and 5 is very satisfying), how was your last experience?
    - (If 1-2) Could you explain why?
    - (If 4-5) What made it so satisfying?
- **Habit and frequency**
  - Is running/cycling a habit for you?
    - (If yes) Do you run/cycle 2 to 4 times a week?
    - (If not) May I ask why?
- **Routine and places**
  - Tell me about your typical day when you go running/cycling.
  - Where do you usually practice?
  - Is there a place you consider special?
  - Can you tell me 3 positive and 3 negative things about the place where you practice?
- **Social and seasonal variables**
  - Do you usually practice alone or with others?
  - In which season do you prefer to practice?
  - Do you change location based on the temperature?
- **Frequency and satisfaction**
  - Are you satisfied with how often you run/cycle?
  - Is there a reason why you can't run/cycle more frequently?
- **Breaks and routes**
  - Do you take at least one break during your workout?
  - Do you usually follow the same route or change it up?
  - Do you use any devices that help you in the sport you're practicing?

During the interview phase, each participant took turns assuming the roles of interviewer, recorder, and photographer.

- **Interviewer:** responsible for asking questions during an interview to gather information, insights, or opinions from the interviewee. They guide the conversation, ensuring it stays on topic, and assess the responses to draw valuable conclusions.
  - The Tablet was used to read the questions to ask the interviewees and to take note of their answers.
- **Recorder:** responsible for capturing and preserving conversations or meetings, either through written notes or by using audio/video equipment to ensure an accurate record of the discussion.
  - During the interviews the smartphone was used as a recorder.
- **Photographer:** responsible for capturing images during interviews or of significant objects, ensuring visual documentation that complements the narrative or setting of the event.

### 3.2.3 Results

#### 3.2.3.1 Pictures





**Komoot** is an app designed for outdoor enthusiasts, helping users plan customized routes for activities like hiking, cycling, running, and mountain biking.

We developed a Python script utilizing OpenAI's Whisper API to transcribe audio tracks into text. Subsequently, the generated transcriptions were compared with the original source to ensure high accuracy and reliability. From these transcriptions, we identified and extracted the **key elements**, filtering out any content deemed irrelevant.

### **3.2.3.1 Key Quotes**

The following key quotes were extracted:

1. "I like to ride a bike to stay in shape, especially in the summer."
2. "You stay in shape, it's fun, you discover the city."
3. "I also go to the mountains in gear five... I like working my legs."
4. "I go to Valentino Park, it's my favorite place to run."
5. "Running allows me to take a break from studying and working."
6. "I used to play football and wanted to keep doing sports."
7. "I prefer running because it's easier and more accessible than cycling."
8. "I'm preparing for a marathon, so I run five times a week."
9. "I started running because I wanted to do a marathon, that was my goal."
10. "I like the freedom of practicing the sport outdoors with flexible timing."
11. "When it rains or the weather is bad, it becomes hard to run."
12. "I love the mountains, so I chose cycling because walking bores me."
13. "Cycling lets me see places that I wouldn't see on foot."
14. "It's dangerous to cycle in the city; it's better to go out of town."
15. "I started running to lose weight, and now it's become a passion."
16. "Running helps me stay in shape and socialize."
17. "I run every day, it's become a habit."
18. "Cycling allows me to disconnect from work and spend time outdoors."
19. "The Turin hills are my favorite place; there's clean air and few people."
20. "I should cycle more often, but sometimes I'm too lazy."
21. "Running allows me to enjoy the outdoors and listen to music."
22. "I prefer running along the Po at Valentino Park; it's a quiet place."
23. "Running through traffic is one of the downsides."

## **3.3 Synthesis**

### **3.3.1 Brainstorming Process**

Once the interviews were completed, it became the right opportunity to focus on brainstorming sessions to identify the most pressing needs of scientific researchers. In other words, the focus shifted to extracting the key needs of our stakeholders. We divided the 8 transcriptions among ourselves (2 each) and extracted the needs from the key elements of each file.

The tool used was *Miro*, an online collaborative platform that provides a digital workspace for creating interactive virtual whiteboards.

Through the use of *Miro*, a systematic categorization of the identified needs was conducted, improving both the understanding and organization of the information.



### 3.3.2 List of Brainstormed User Needs

The list of **user needs** is as follows:

1. Need a way to experience a sense of personal achievement during outdoor exploration
2. Need to find hidden or uncharted routes during exploration
3. Need to be able to establish a consistent routine that allows users to explore new environments without disrupting their daily commitments
4. Need to disconnect from daily stress by immersing themselves in nature through outdoor exploration
5. Need to adapt exploration plans based on weather and environmental conditions
6. Need a way to engage with communities or other users during outdoor exploration
7. Need to incorporate diverse physical activities that enhance both fitness and exploration
8. Need to overcome physical challenges to reach remote or difficult-to-access locations
9. Need a way to stay safe during exploration, especially in remote or unfamiliar areas

User need 1 derives from the following interviews:

- **Interview 2** - "Can you tell me three positive and three negative aspects of running?"

*"Staying in shape... or maybe breathing fresh air if you choose places with greenery..."*

- **Interview 5** - "Could you tell me three positive and three negative aspects of cycling?"

*"Well, positive aspects: movement, so health, being outdoors, and then seeing new places."*

- **Interview 6** - "Is there any place where you run that you consider special?"

*"Well, since we live here in Turin, the Turin hills definitely offer a great location. Clean air, I suppose. Also, a clean environment and a different kind of route."*

User need 2 derives from the following interviews:

- **Interview 3** - "When you come here to Valentino, do you always follow the same route, or do you change it?"

*"I change, I change... One day one route, yesterday I did another, today I'm doing a different one, so I try to switch it up... I'm always looking for new routes."*

- **Interview 5** - "Do you always follow the same route, or do you change it?"

*"No, I try to change often. Even within the same place, I try to take different routes that I may have never done before."*

- **Interview 6** - "Do you always follow the same route, or do you change it?"

*"No, no, I change it as well. Yes, yes, two or three times a week, I take different routes."*

- **Interview 8** - "Anyway, going back to running, which is the main focus of this interview, could you tell me three positive and three negative aspects of running?"

*"...I run through busy areas, so I'd say smog. Sometimes there isn't a clear and well-defined path, and I have to cut through streets that aren't very convenient. Other than that, no, nothing else negative."*

User need 3 derives from the following interviews:

- **Interview 1** - "Do you always follow the same route, or do you change it?"

*"I try to follow the same route because, well, it helps me optimize my time. So, I tend to repeat it, especially with other priorities like my wife and kids."*

- **Interview 7** - "Do you always follow the same route, or do you change it?"

*"I tend to change it when I can, but more often, I repeat the same routes I'm used to, so I don't waste too much time."*

User need 4 derives from the following interviews:

- **Interview 3** - "So, first of all, why did you start running?"

*"Because it makes me feel much better, especially to reduce stress."*

- **Interview 7** - "Could you tell me three positive and three negative aspects of cycling?"

*"Positive aspects: it's a sport, you spend some time outside, you take a break from work, and it helps reduce stress."*

User need 5 derives from the following interviews:

- **Interview 1** - "Based on the temperature or weather conditions, do you change location?"

*"No, if it rains, I don't go. It wouldn't make sense for me."*

- **Interview 3** - "In which season do you prefer to go?"

*"It doesn't matter."*

*"Do you change location based on the temperature? Does the time of day change?"*

*"Yes, but I always prefer it when it's not too hot. "I can handle the cold, actually, but I prefer it not to be too hot."*

- **Interview 4** - "Could you tell me three positive and three negative aspects of running?"

*"Boredom, you almost always do it alone, and if the weather is bad, it becomes difficult to do."*

*"And in which season do you prefer to go running?"*

*"April, let's say, so spring. When it's neither too hot nor too cold."*

*"Do you change location based on the temperature?"*

*"Always at Valentino."*

- **Interview 7** - "In which season do you prefer to go cycling?"

*"All seasons except late autumn and winter."*

*"Based on the temperature or weather conditions, do you tend to change location?"*

*"Yes, well, yes, definitely... I mean, in the mountains, when it's colder, I tend to go less and stay around here more."*

User need **6** derives from the following interviews:

- **Interview 4** - "Could you tell me three positive and three negative aspects of running?"

*"Boredom, you almost always do it alone, and if the weather is bad, it becomes difficult to do."*

- **Interview 5** - "Do you usually practice alone or with others?"

*"No, I'm usually in company... Not large groups, but at most one or two people."*

- **Interview 6** - "Do you usually practice alone or with others?"

*"No, usually alone, but also in company when it happens. It's really nice to do it with others as well."*

- **Interview 8** - "Do you usually practice alone or with others?"

*"It depends... Sometimes alone, sometimes with others. I prefer it that way."*

User need **7 - 8** derives from the following interviews:

- **Interview 6** - "Do you practice any other sports besides running?"

*"Yes, bodybuilding and gym workouts."*

"Could you tell me three positive and three negative aspects of running?"

*"Definitely, the main positive aspect is that it helps you stay in shape."*

"Do you remember the first time you got into running?"

*"Yes, about 21 years ago. I was overweight, and like 90% of runners, I started running for this reason."*

"On a scale from 1 to 5, where 1 is very boring and 5 is very satisfying, how was your last experience?"

*"For me, it was very satisfying..."*

"And why was it particularly satisfying?"

*"Because of the performance, the location, and the goals I wanted to achieve."*

- **Interview 8** - "Could you tell me three positive and three negative aspects of running?"

*"...Boredom, you almost always do it alone, and since it's a solitary sport, there isn't the same interaction as in other sports."*

User need **9** derives from the following interviews:

- **Interview 7** - "Could you tell me three positive and three negative aspects of cycling?"

*"Few cycling lanes, and it's somewhat dangerous due to traffic."*

### 3.3.3 Deep user needs

To ensure a comprehensive understanding of user expectations, we analyzed various needs expressed by stakeholders and categorized them based on their relevance to outdoor exploration. From this process, we identified four fundamental user needs that encompass a broad range of challenges and preferences:

1. *Need to find hidden or uncharted routes during exploration;*
2. *Need to adapt exploration plans based on weather and environmental conditions;*
3. *Need a way to stay safe during exploration, especially in remote or unfamiliar areas;*
4. *Need a way to engage with communities or other users during outdoor exploration;*

### 3.4 Identifying solutions

Once we had clearly defined the core user needs relevant to our project, we moved on to the process of developing targeted solutions. To ensure a structured and inclusive ideation process, we adopted a collaborative brainstorming approach using **Miro**. Our methodology consisted of two key phases:

1. **Divergent Thinking:** Each team member individually generated as many potential solutions as possible within a five-minute timeframe. This step encouraged a broad exploration of ideas without constraints.
2. **Prioritization and Selection:** We implemented a collective voting system, where each participant was assigned three votes to indicate the most promising solutions. To maintain objectivity, individuals were not allowed to vote for their own ideas.

Through this iterative process, we refined the most impactful solutions corresponding to each *Deep User Need*.

To address users' desire for unique and less-traveled paths, we identified the following solutions:

- **Explorer-Friendly Zones:** Certain areas or trails are designated as 'explorer-friendly zones' where users can find hidden or less-known paths.
- **Community-Based Knowledge Sharing:** Local communities offer insights into uncharted or secret locations for a more immersive exploration.

- **Enhanced Mapping Systems:** Maps or guides highlight off-the-beaten-path routes that are less frequently explored by the public.
- **Gamified Discovery Experience:** Users can access a system that ranks and rewards discovering new or hidden routes.
- **Landmark Exploration Challenge:** Users participate in a game to find hidden or less-known landmarks in remote areas.

To meet users' need for adaptable exploration plans in response to weather and environmental changes, we identified the following solutions:

- **Coordinated Explorer Groups:** Coordinates groups of explorers, recommending rescheduling for all participants based on weather conditions.
- **Shelter and Emergency Hub Visibility:** Users can see the location of shelters or base stations in case of sudden weather occurs before continuing their exploration.
- **Intelligent Weather-Based Navigation:** Dynamic navigation for users based on the weather to alert users about changing conditions on their route offering rerouting options based on incoming storms or environmental alerts, ensuring user safety while exploring.
- **Exploration Timing Optimization:** Users can see the best times to explore based on past environmental patterns and forecasts.
- **Crowdsourced Weather Updates:** A network of users shares real time weather updates to help others adapt their plans.

To fulfill users' need for social interaction and engagement with communities during outdoor exploration, we identified the following solutions:

- **Organized Outdoor Events:** Outdoor events are organized where users can share their experiences and discoveries.
- **Recognition and Contribution Rewards:** Communities recognize and reward users who contribute valuable insights or discoveries about new areas.
- **Collaborative Exploration Journals:** Groups of users create shared journals or logs to document their collective experiences and discoveries.
- **Personal Exploration Diaries:** Each user keeps their own public diary to share their experiences.
- **Interest-Based Connection Platform:** A service that connects people based on similar exploration interests. It can match users who want to share experiences or even explore together.

To ensure users' safety during exploration, especially in remote or unfamiliar areas, we identified the following solutions:

- **Emergency Safety Stations:** Remote areas are equipped with safety stations where users can access emergency supplies or assistance during the exploration phase.
- **Wearable Emergency Devices:** Users use wearable devices that send out signals in case of an emergency or if they are lost.

- **Certified Exploration Guides:** Safety-certified exploration guides or services ensure the safety of users in unfamiliar or remote locations.
- **Virtual Breadcrumb Trails:** Users leave a trail of virtual markers during their exploration that can be used in case of trouble.
- **Safe Exploration Zones:** Special trails or zones are designated as 'safe exploration areas' with enhanced support and monitoring systems while exploring.

### 3.5 Final proposed solution

After a brainstorming session and a group vote, we refined our chosen solution to create a more immersive and interactive approach to outdoor exploration. Our concept evolved into a **gamified experience**, where users actively engage in challenges to locate hidden or lesser-known landmarks in remote areas. This solution not only satisfies the need for discovering uncharted paths but also encourages **exploration, adventure, and community participation**.

### **Wanderlust**

*“A never-ending journey”*

## 4. Tasks and Storyboard

### 4.1 Task Analysis

Once the definitive solution was picked to meet the user's need halfway, we spent some time reflecting on what our target user should be able to do with our potential application. The goal of this part was to select three tasks, which differ from each other, that were categorized by means of their complexity and frequency in order to move forward with our prototype development.

The categories mentioned earlier and defined for this brainstorming session are, respectively, Simple Task, Moderate Task, and Complex Task.

After some setbacks and a few days passing by, we came up with the following tasks:

- **Simple:** Choose a route to discover new landmarks in the game while engaging in outdoor activities.
- **Moderate:** Complete mini-challenges within the game to unlock unique landmarks along the route.
- **Complex:** Add new landmarks to be used in subsequent games by other users.

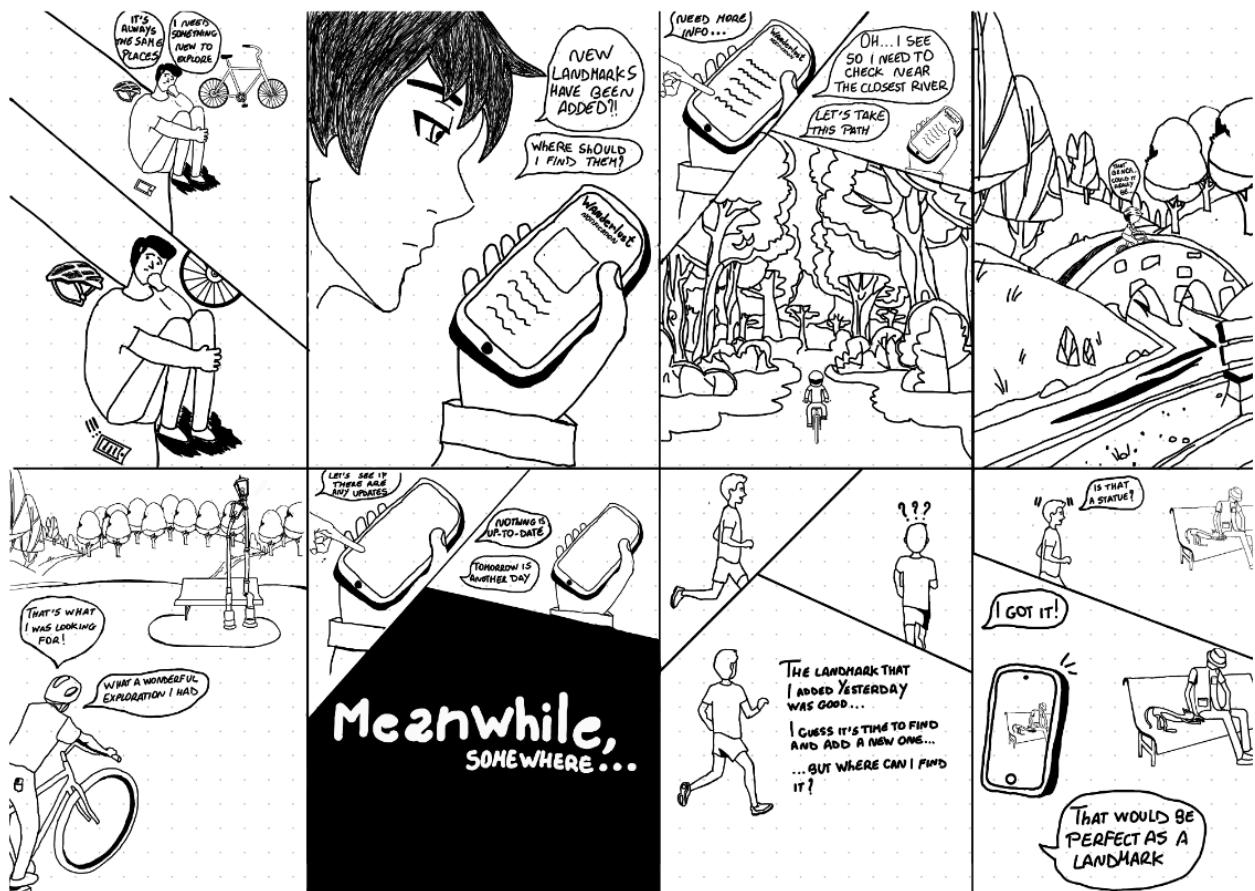
By definition of **Complex Task**, instead of selecting it based on frequency, we decided to define it by the user who should perform it: the expert user.

The main reason we selected these tasks stems from the key insights gathered during the needfinding phase. A common challenge reported by users was the difficulty of discovering

hidden or uncharted routes, particularly in remote areas. Many also highlighted the absence of effective tools to assist them in this kind of exploration, which often resulted in a less fulfilling outdoor experience.

This lack of support can make it harder for users to engage in meaningful exploration, potentially discouraging them from seeking out new paths. To address this issue, we structured our solution around tasks that progressively guide users toward discovering and engaging with lesser-known landmarks. By providing a clear path from simple route selection to active contribution, these tasks ensure that users remain engaged and motivated while also fostering a collaborative environment where new discoveries are continuously shared.

## 4.2 Storyboard



After having found the three main tasks for our project, we focused on the next step, which aims to create a storyboard in order to show how a hypothetical user could approach our potential application.

During this phase, we faced several conflicts within the group regarding which 2 out of the 3 tasks to show in the storyboard.

Because of this, we temporarily decided to split the group into two sub-groups. The first one chose to represent the simple and complex tasks, whereas the other one decided to show the

simple and moderate tasks.

In the end, we compared both and, after a secret internal vote and some advice from the professor, we decided to pick the one that represents the simple and complex tasks, as it allows us to highlight the details in a more precise way.

To summarize, the storyboard, which refers to the simple and complex tasks, tells the story of a cyclist who struggles because he is not able to find new places to explore and always ends up in the same spots. Thanks to some advice from Wanderlust, he is able to explore new areas and discover new landmarks in a playful way. Meanwhile, another user, an expert one, finds a particular landmark and decides to add it to Wanderlust.

Despite all the effort that led us to define the best storyboard, having this one does not come only with strengths but also with weaknesses, which are outlined as follows:

**Strengths:**

- It highlights the difficulties a user faces when trying to find new places to explore during outdoor activities.
- The setting in which the whole story unfolds is effectively emphasized.
- The story represents a guided journey that starts with a problem and leads to a solution.

**Weaknesses:**

- It was challenging to provide a more complete characterization of the second character (the expert user).

To better explain, the overall storyboard clearly highlights the difficulties encountered by the user during his journey and how he ultimately finds a solution. Additionally, the storyboard effectively emphasizes the environment in which these difficulties occur.

On the other hand, since we represented two characters, we faced the problem of a lack of characterization for the second one (the expert user). Despite this, we believe the storyboard is good enough to clearly showcase both tasks.

In the end, the storyboard captures the need to find hidden routes by showing how the app guides the character to new landmarks, supporting the goal of unique exploration. By turning this process into an engaging and interactive experience, it effectively demonstrates how the app meets the identified need. The combination of playful discovery and expert contributions ensures that both casual explorers and experienced users benefit, making the app a valuable tool for uncovering uncharted paths and enhancing the exploration experience.

## 5. Low-Fidelity Prototypes

### 5.1 Modalities Exploration

In this section, we will talk about the process through which we identified various interaction modalities in order to pick the most suitable ones for outdoor activities.

Our goal was to find solutions that allowed users to interact with the app easily while moving. The objectives were:

- **Accessibility:** Ease of accessing features while running or moving.
- **Visibility:** Ability for users to clearly view important information.
- **Usability on the move:** How easily users can interact without interrupting physical activity.

After a brainstorming session within the group, we decided that the most noteworthy modalities were:

- Smartphone + Touch
- Smartphone + Speech
- Smartwatch + Touch
- VR + hand motion

To better analyze all the scenarios, we made a list of pros and cons for each modality in order to choose the best **two** out of the four modalities listed above, which are outlined as follows:

#### 5.1.1 Smartphone + Speech

##### Pros:

- Voice commands allow users to interact with the app without needing to touch the screen

##### Cons:

- Background noise from traffic, wind, or other environmental factors can interfere with speech recognition, reducing accuracy and reliability
- Voice commands are typically limited to simpler tasks; for more complex interactions, users may need to switch back to touch

#### 5.1.2 VR + hand motion

##### Pros:

- Playing in a virtual universe might unlock a limitless number of ways to interact with the environment

**Cons:**

- The weight and the battery capacity have a big impact on the performance of the user
- Using a headset that limits or completely excludes your field of view may cause serious injury

### 5.1.3 Smartphone + Touch

**Pros:**

- The bigger display allows for more information to be shown, making it easier to view maps, and route details.
- Users are generally more accustomed to touch interaction on a smartphone, making it intuitive to use.

**Cons:**

- Taking out the smartphone during physical activity can interrupt the flow, requiring time and attention.
- Holding or retrieving the smartphone can be uncomfortable or impractical, especially on steep or uneven paths.

### 5.1.4 Smartwatch + Touch

**Pros:**

- Conveniently worn on the wrist, the smartwatch is always accessible, ideal for quick glances and interaction during activities like running.
- Enables users to interact on the go without stopping, perfect for those seeking an uninterrupted, immersive experience.
- Removes the need to carry the extra weight of a smartphone and any gear required to hold it, allowing for lighter and more unrestricted movement.

**Cons:**

- The reduced display limits the amount of information that can be shown legibly.

At the end of this analysis we selected **Smartphone + Touch** and **Smartwatch + Touch** as the best modalities to adopt.

Both alternatives show a big advantage with respect to the cons that inevitably may show everywhere.

The other alternatives were discarded for specific, notable reasons:

- VR + hand motion: was too unsafe to use.
- Smartphone + speech: Useful with minimal effort, but the commands are limited to basic ones, often unreliable, forcing the user to reply to a touch ecosystem.

## 5.2 Paper prototypes

In this section we present the two prototypes developed based on the two selected interaction modalities discussed in the previous section which are the **Smartphone + Touch** and **Smartwatch + Touch**.

### 5.2.1 Smartphone + Touch Prototype

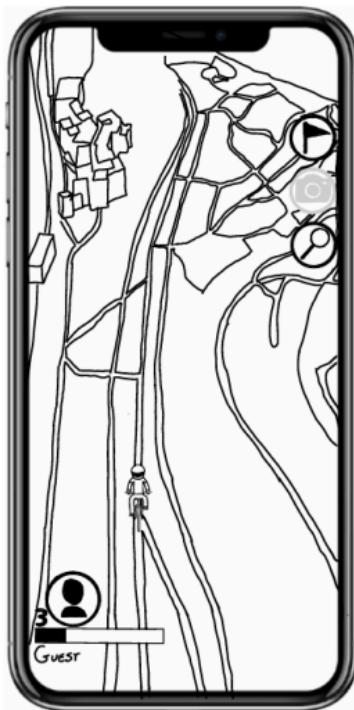


Figure 5.1: Main page in which the user, in this case a non logged-user, can interact in order to accomplish all the tasks.

The idea behind this prototype starts with an interactive map through which the user can navigate. More specifically, each real-world movement should be translated into movement on the map, as indicated by the player icon.

Moreover, in the upper right corner, we placed three buttons, which are the main components that allow the user to accomplish the three tasks discussed in the **Task Analysis** section.

An experience bar was also added to make the interaction more engaging and playful.

Going back to the three main components, from top to bottom, they can be defined as follows:

- **Flag button:** By default this button is disabled and only after choosing a route (by clicking on one of the markers on the map), the user can see all the details related to that route.
- **Camera button:** This button is disabled for guest users. Only logged-in users can use it to add new landmarks to the game.
- **Magnifying glass button:** This button provides the user with the latest updated map to access newly available routes.

Considering all these aspects, for **Prototype 1**, we decided to develop a **centered main page application** (Figure 5.1), where the user can navigate through each functionality while always keeping the main page in the background. The reason behind this structured and lightweight design was to support error-prone users and facilitate interaction with a new application.

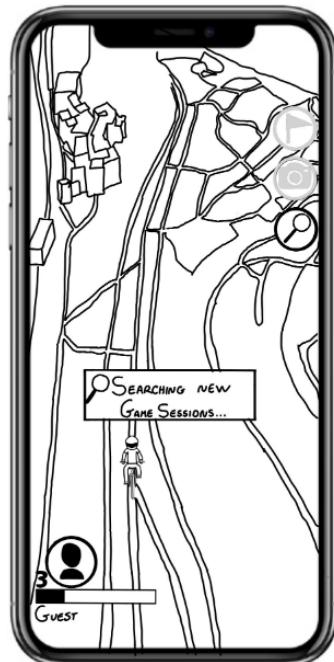


Figure 5.2: After clicking the magnifying glass button, the system displays a popup notifying the user that it is searching for new game sessions.

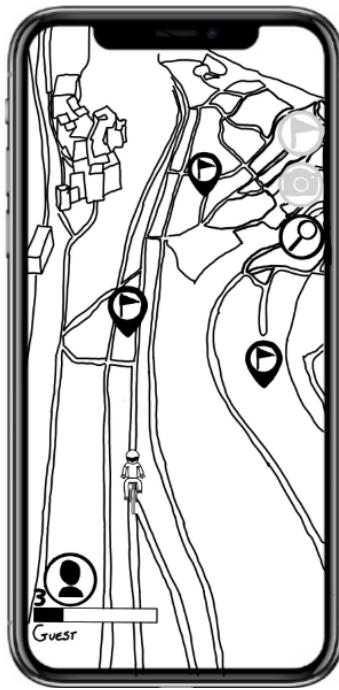


Figure 5.3: Different markers, each associated with a game session, appear as a result of pressing the magnifying glass button.



Figure 5.4: As a result of pressing the marker with a flag icon on the map, the system displays a popup, allowing the user to accept the game session associated with that marker. The image inside the popup, which depicts a map, helps the user understand where the game should be played.

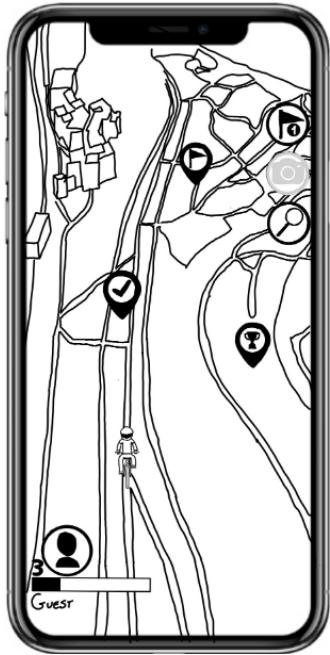


Figure 5.5: As a result of pressing the accept button in Figure 5.4, it shows a checked marker on the map, indicating that the game session has been accepted, along with a design update in the top-right flag button, with the number 1 displayed next to it



Figure 5.6: After pressing the new top-right flag button (shown in Figure 5.5), a popup appears displaying the rules for the selected game session. Pressing 'Next' allows the user to start playing the accepted game session.



Figure 5.7: This is the first page of the game, where the user must solve a riddle to find a hidden landmark. There are also two buttons: the bullseye target represents an extra challenge, while the question mark provides a hint to solve the riddle.

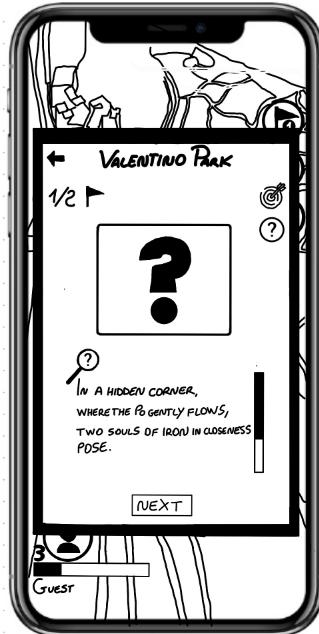


Figure 5.8: This is still the same screen as in Figure 5.7, but at a moment when the user is near the hidden landmark and the 'Next' button has appeared as a result.



Figure 5.9: This screen displays the extra challenge popup, which appears after tapping the bullseye target button. The user can complete extra challenges to unlock the opportunity to find a unique landmark.

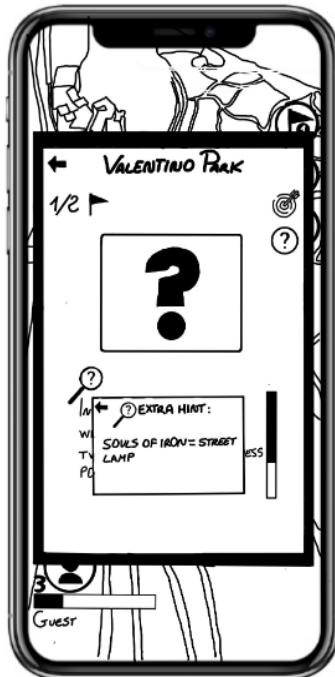


Figure 5.10: By tapping the question mark circle button, the extra hint popup appears to help the user solve the riddle.



Figure 5.11: This page appears when the user is next to the landmark and has pressed the 'Next' button. On this page, the user must vote on whether they have found the landmark or not.



Figure 5.12: In the voting phase, the user must press one of the thumbs to enable the 'Next' button and proceed further into the game.



Figure 5.13: This is the final page of the selected game session. This scenario occurs only when all the landmarks have been found and the challenges were completed correctly. Completing the challenges correctly allows the user to unlock a unique landmark to be found.



Figure 5.14: This is also the final page (shown in Figure 5.13), but it occurs when all the landmarks have been found and the challenges were not completed.

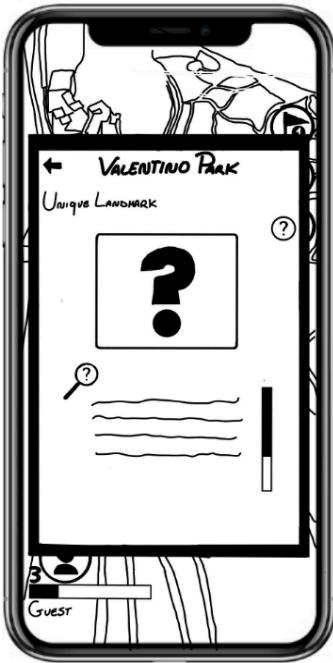


Figure 5.15: This page refers to the unique landmark, unlocked by completing the extra challenges. Only when the scenario in Figure 5.13 occurs can the user press the 'Continue' button to reach this page and try to find the unique landmark. Unlike the other pages, there is no bullseye target button here, as the extra challenges were only used to unlock the unique landmark.



Figure 5.16: This is the vote page for the unique landmark. After voting, as shown in Figure 5.12, and pressing 'End', the selected game session is fully completed.

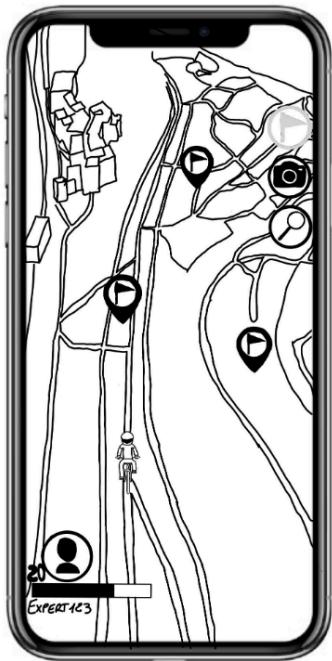


Figure 5.17: This is the main page from the logged-in user's point of view. The logged-in user has the same functionalities as the guest user, with the addition of the 'Add Landmark' button, displayed as a camera icon in the top-right corner.



Figure 5.18: Tapping the camera icon button will trigger this popup, allowing the user to add a new landmark within the game. The user can take a picture of a newly discovered landmark, add a label with the landmark's name, and share their current position, which will be associated with the landmark's location.

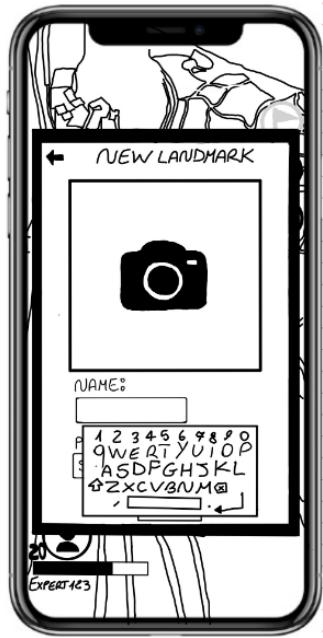


Figure 5.19: After tapping the name field, a keyboard will appear, allowing the user to type a name for the new landmark they want to add.

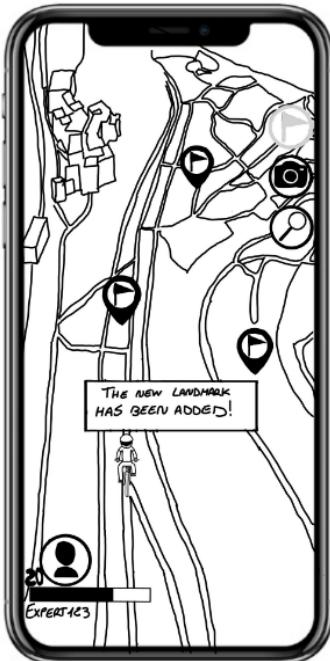


Figure 5.20: After filling out all the fields in Figure 5.18, tapping the 'Add' button will display a message informing the user that the new landmark has been added.

## 5.2.2 Smartwatch + Touch

Regarding **Prototype 2**, we provide an initial main page where the user can start a new game session or add a new landmark. After selecting the difficulty mode, the user can fully immerse themselves in the game session.

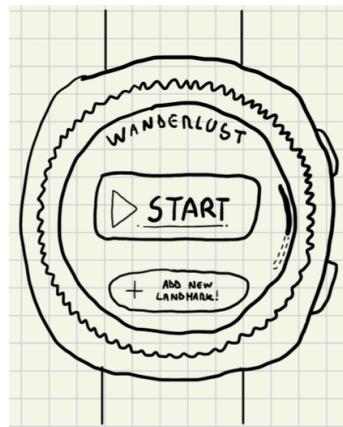


Figure 5.21: This is the initial page in which the user can choose between **start a new game session** or **add a new landmark**.

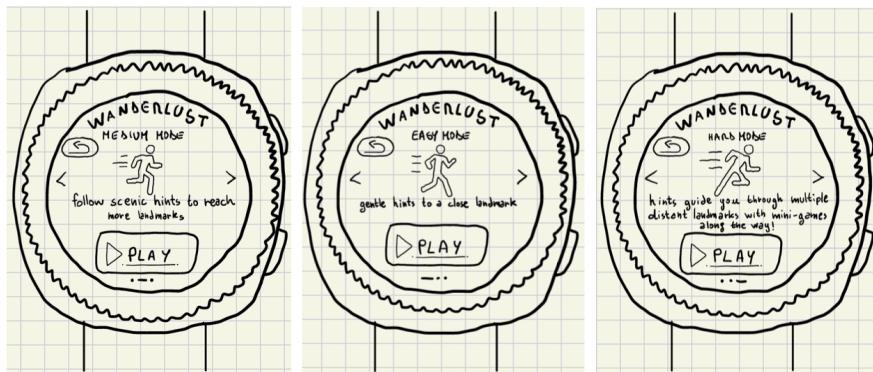


Figure 5.22: These are the **difficulty selection pages**. Each difficulty level varies in **length** and the **complexity** of the hints.

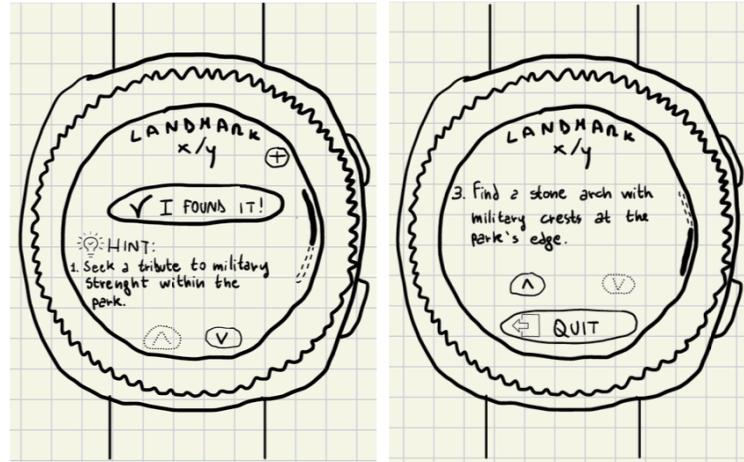


Figure 5.23: The left screen presents a **hint** to help the user find a specific landmark, along with a “+” icon to allow a user to add a new landmark and an **‘I Found It!’** button to confirm the discovery. The right screen represents what the user would see if they **scrolled down** (by tapping on the arrow icon or by rotating the smartwatch gear) on the left screen, revealing additional clues. After viewing all the clues, the user has the option to press the **‘Quit’** button to exit the session.

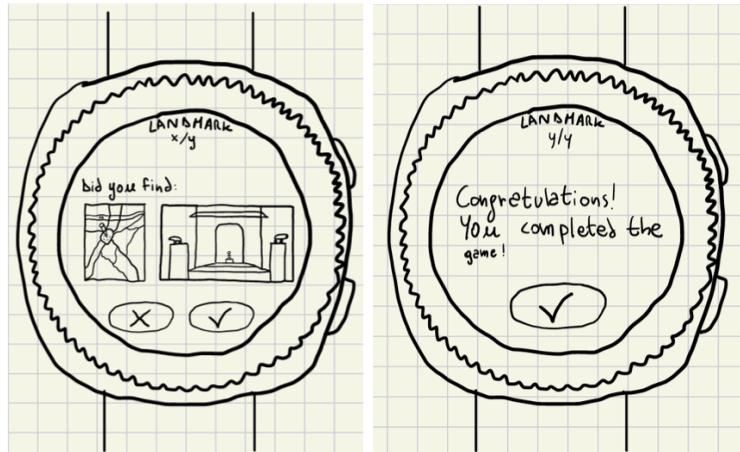


Figure 5.23: These figures illustrate the **final stages** of a game session in Prototype 2. The left screen shows the **verification step**, where the user must confirm their discovery by verifying the correct landmark based on its position and image. Pressing the checkmark button confirms the choice, while the ‘X’ button allows for reconsideration. The right screen represents the **game completion message**, which appears after successfully identifying all landmarks. A confirmation button allows the user to acknowledge their achievement and exit the session.

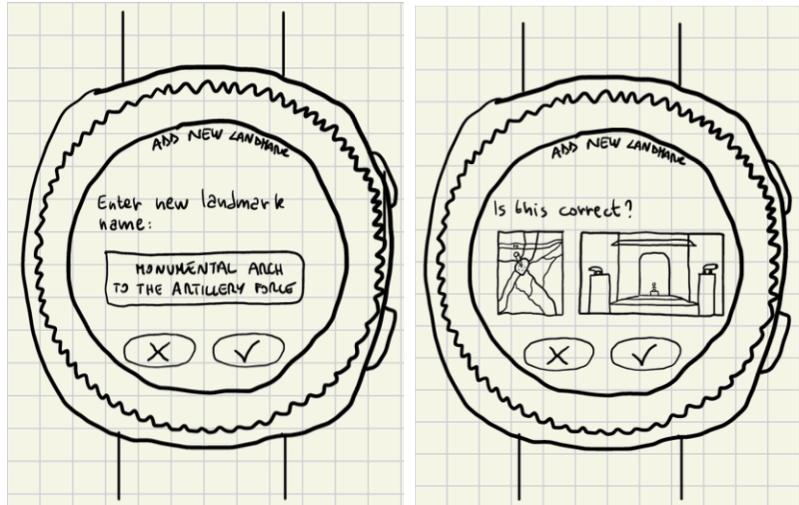


Figure 5.24: This figure represents the process of **adding a new landmark**. The left screen allows the expert user to enter the **landmark's name** and confirm or cancel the action using the checkmark or 'X' button. The right screen is the **verification step**, where the user ensures that the intended landmark matches the corresponding image and its position on the map before finalizing the addition.

### 5.2.3 Connection with storyboard, project goal and three tasks

Both our prototypes can be used to perform all the three tasks:

- **Simple task:**

- In Prototype 1, the user can choose a route through a series of actions: tapping the magnifying glass to update the map and display markers representing the game sessions around them, then tapping one of the markers to select the desired game session (the route to be played).
- In Prototype 2, the user can tap the “START” button to begin its journey. Moving in the difficulty selection screen by tapping the arrow icons or by moving the smartwatch gear allow the user to select its difficulty of choice for the current game and, by pressing the play button, the game begins.

- **Moderate task:**

- In Prototype 1, during an ongoing game session, which can be accessed by tapping the flag button in the top-right corner, the user can complete mini-challenges (Figure 5.9) to unlock unique landmarks along the route.

- In Prototype 2, after tapping the “START” button, the user can select the “Hard Mode” difficult. This specific mode, allows the user to enrich its journey with challenging scenario to discover further unique landmark
  
- **Complex task:**
  - In Prototype 1, as a logged-in user, the camera icon button is enabled. The user can add a new landmark by tapping the camera button, which triggers a popup where the user must complete all the required fields. After clicking the 'Add' button, the system will notify the user that the landmark has been successfully added.
  - In Prototype 2, the “Add New Landmark” button can be tapped to allow the user to add a new landmark to the application, the same functionality button can be found while playing, alongside the “landmark” title with a “+” icon to allow the user to add landmark they may find along the way while playing. The user, from here, a new interface appears allowing the user to write the name of a Landmark and, after confirming, prompting him to check the correctness of the new landmark to be added.

Both of our prototypes are aligned with the **project goal**, as they help the target users explore the world during their outdoor activities in a playful way, by allowing them to discover new hidden landmarks through a series of riddles.

The prototypes are also aligned with the **Storyboard** in terms of exploration and the behavior of the actors. More specifically, Prototype 1 distinguishes between the two actors presented in the storyboard: the Guest user (immediate user) and the logged-in user (expert user). Prototype 2 adopts an intrinsic approach, where the user's level of expertise is determined based on their knowledge, allowing them to freely decide whether or not to add a new landmark within the game.

## 5.2.4 High-level flow

**Prototype 1 Smartphone + Touch:**

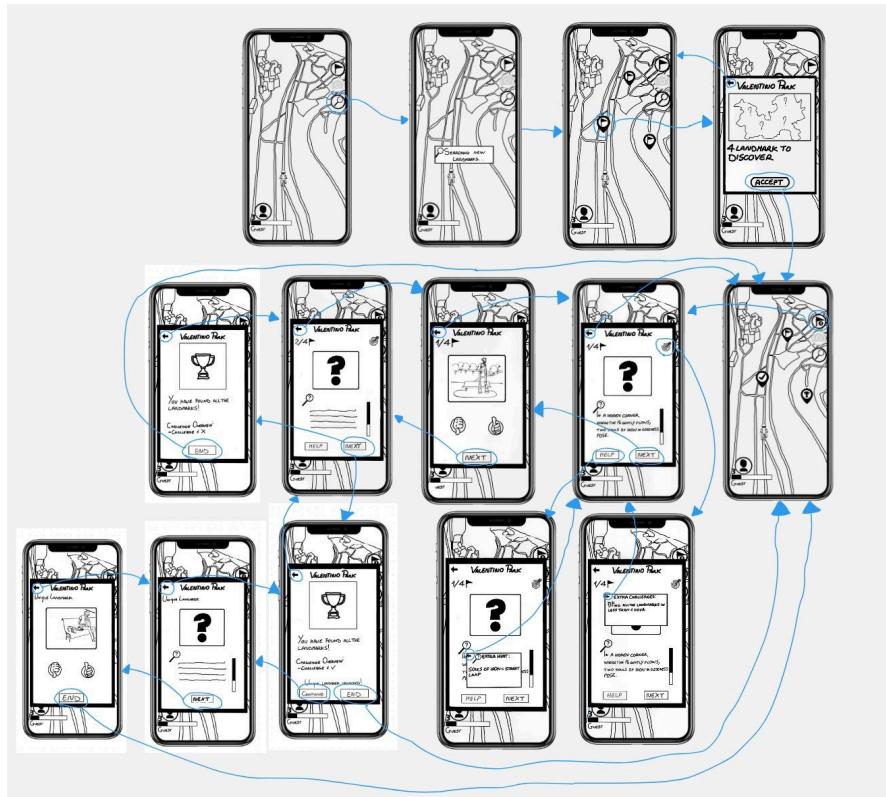


Figure 5.25: High-level flow of the Guest View in Prototype 1. For a better visualization, refer to this [link](#).

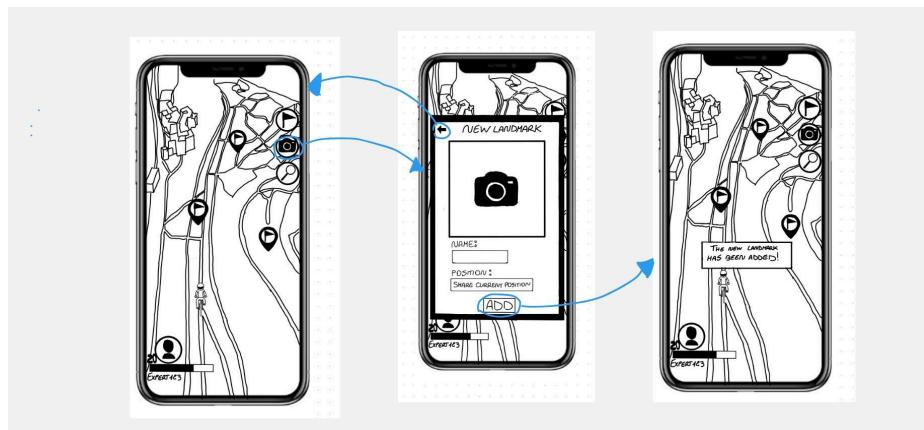


Figure 5.26: High-level flow of the logged-in View in Prototype 1. For a better visualization, refer to this [link](#).

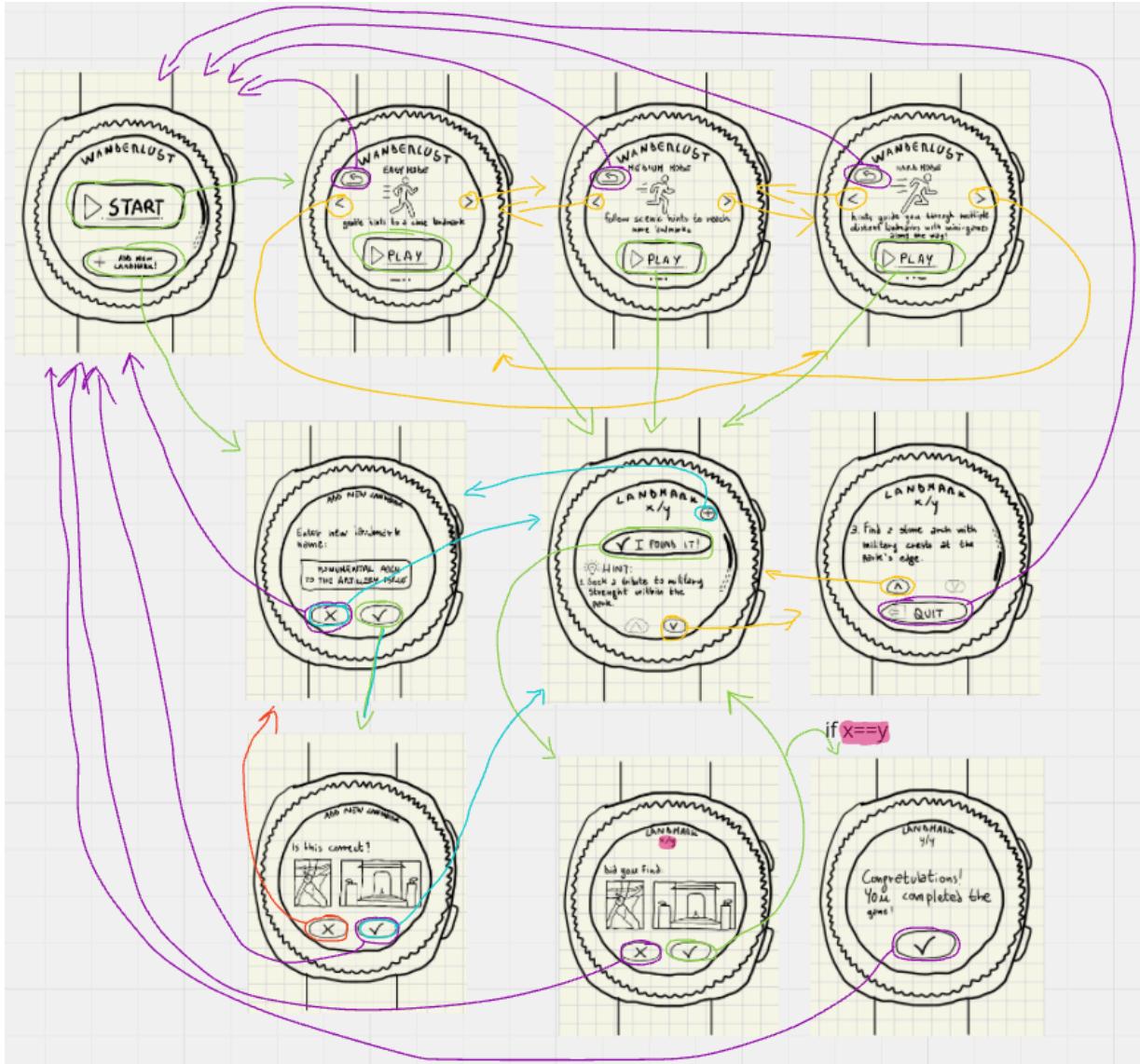


Figure 5.27: High-level flow of the Prototype 2. The colored lines help to understand the flows: the **green** color represents a vertical flow between the interfaces, the **yellow** color represents a lateral movement between the interfaces (e.g., selecting the difficulty), the **purple** color represents a jump to the “landing page”, the **cyan** color represents the alternative flows where the “add a new landmark” action is done from within the game in contrast of doing such action from the “landing page”, the **orange** color represents a step back in the interface, but to separate such action when the “X” icon is tapped inside the “add new landmark” (first interface) the corresponding **purple** and **cyan** color are used to understand where such action produces specific results. Finally, the **pink** color is used to highlight the branch condition for the final page of the game.

### 5.3 Heuristic Evaluations

This section describes the heuristic evaluations conducted for our two low-fidelity prototypes. These evaluations help us enhance our prototypes in terms of usability and user experience by identifying various violations based on Jakob Nielsen's ten heuristics.

As a result, these violations allow us to recognize usability issues within the prototypes.

Before explaining the execution of the heuristic evaluations, we will first discuss how we prepared all the necessary materials for conducting them.

Since the prototypes were initially created in a digital format, we printed both prototypes along with a corresponding cover representing the devices on which the application would run (smartphone and smartwatch). Each screen was cut out and glued together to create a sort of sliding window mechanism, which was used during the evaluation as follows:

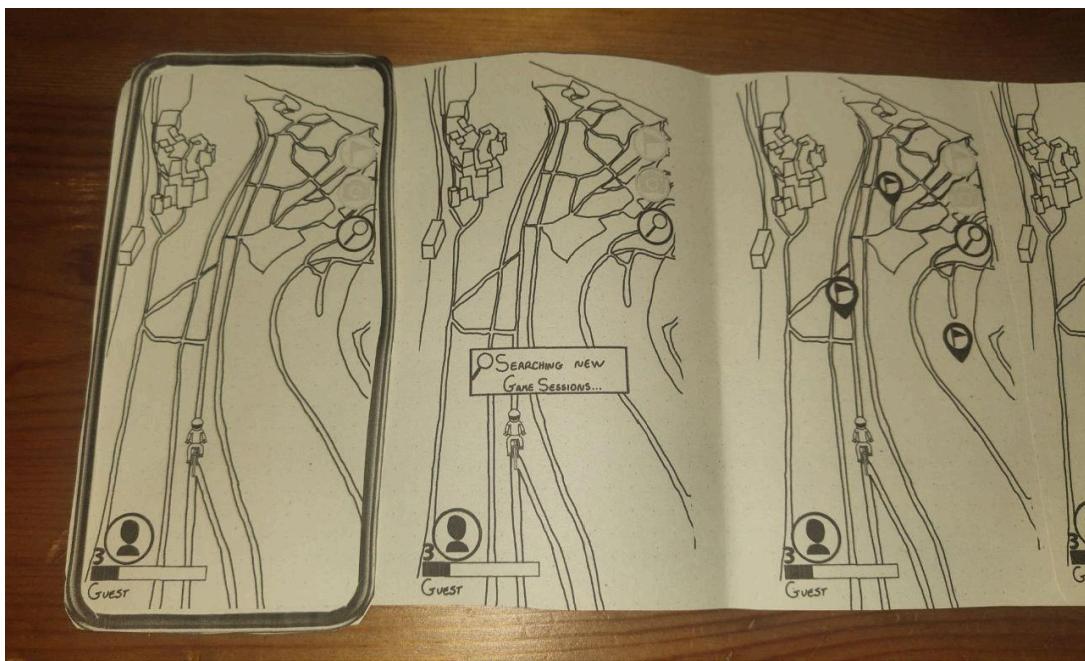


Figure 5.28: Printed copy of prototype 1 with a sliding window mechanism

Almost simultaneously with the creation of the printed copy, we assigned each group member a role, either Facilitator or Computer, for the execution phase. Since one group member was unable to participate due to health issues, the roles were distributed as follows:

- Daniele Bruscia (Facilitator) and Marco Profilo (Computer) for the evaluation sessions of Prototype 1.
- Francesco Gabrieli (Facilitator) and Daniele Bruscia (Computer) for the evaluation sessions of Prototype 2.

The Facilitator's duty is to assist the evaluators by explaining how the session works and providing them with the three tasks, the project solution, and any necessary context.

On the other hand, the Computer manipulates the pieces of the printed prototype based on the evaluator's interactions.

The evaluators were picked from other HCI groups and the execution phase was made during lab hours in a semi-controlled environment.

A total of four evaluations were conducted for the prototype 1 and for the prototype 2 were conducted three evaluations.

Moving forward with the execution phase, each evaluator was tested individually. The process began with the Facilitator explaining the environment for which the prototype was designed, the target users and their age, the three tasks, and the project solution.

At this point, the evaluator proceeded to complete all three tasks independently, while the Facilitator remained available to assist in case of doubts or difficulties. Meanwhile, in the background, the Computer was prepared to manipulate the pieces of the prototype based on the evaluator's actions. The same structure was used for all the evaluations.

In addition to the list of heuristic violations that will be seen later, almost all evaluators provided feedback on the prototypes.

Based on evaluators feedback, the application effectively addresses its main tasks but could benefit from improvements in terms of usability. The key recommendations are:

### **Prototype 1:**

#### **1. User Guidance and Feedback**

- Add **help screens** for non-standard functions and a **mini tutorial** after mission acceptance.
- Introduce an **information icon** for contextual instructions and clarify icon meanings with tooltips.
- Ensure clear feedback through **confirmation screens** for mission acceptance and completion.
- Improve icon intuitiveness, especially for home screen navigation.

#### **2. Navigation and Accessibility**

- Enable **real-time landmark search** and improve navigation with a **home button** and **navigation arrows**.
- Keep **mission information accessible** throughout the mission.
- Allow users to **review found and pending landmarks** to avoid getting stuck.

### 3. Mission and Landmark Management

- Display **accepted missions on the map** instead of hiding them under an icon.
- Allow **mission cancellation** at any time.
- Add a **history of visited places** for post-mission review.
- Clarify that the **unique landmark** becomes inaccessible if not completed.

### 4. Challenges and Landmark Interaction

- Simplify the **challenge completion page** to reduce clutter.
- Use **more intuitive icons** for found/not found landmarks.
- Allow users to **enter addresses manually** and upload photos from the gallery.
- Show map position **directly in the landmark addition screen**.
- Explain why the **camera feature is disabled** (e.g., prompting login to unlock it).

### 5. User Control and Confirmation

- Add a "**Stop**" button to pause or exit the game session.
- Include **confirmation prompts** before game session acceptance/completion.
- Improve clarity and access to **extra challenges**.

## Prototype 2:

### 1. User Guidance and Feedback

- Replace the unconventional **scrollbar** used to navigate between the "Start" and "Add Landmark" buttons with a more intuitive mechanism.
- Ensure **consistency** in terminology by unifying button labels (e.g., "Play" vs. "Start").
- Add a **page title** to improve **recognition** rather than recall in the "Choose Mode" view.
- Remove **unnecessary screen elements** that waste space, especially on smartwatch interfaces.
- **Shorten the description** of "Hard Mode" to improve readability and usability on small screens.
- Provide **better explanations** for key actions to reduce trial-and-error learning.

### 2. Navigation and Accessibility

- Standardize **navigation controls** to avoid **inconsistencies** between screens (e.g., unify arrow button design).
- Allow **horizontal scrolling** instead of using **arrow buttons** to switch between modes.
- Ensure that users **can move** between landmarks **during a session** rather than being restricted to a linear progression.
- Improve **button placement** and size to prevent accidental clicks, particularly for small UI elements like the "**Back**" and "**+**" buttons.
- Make **landmark information** accessible at all times during the session to avoid unnecessary disruptions.

### 3. Mission and Landmark Management

- Ensure that **accepted missions** remain **visible** on the map rather than being hidden under an icon.
- Allow users to **cancel missions at any time** instead of locking them into a session.
- Provide a **post-mission review feature**, allowing users to access a **history** of visited landmarks.
- Improve the **landmark selection** process by displaying multiple search results to reduce input errors.
- Prevent users from **getting stuck** in an incorrect landmark selection loop by refining search functionality.
- Adjust the layout of the "**Found Landmark**" screen to avoid displaying images and location data **too small to be useful**.

### 4. Challenges and Landmark Interaction

- Simplify the **challenge completion page** to improve clarity and reduce clutter.
- **Redesign icons** for found/not found landmarks to be more **intuitive**.
- Allow users to **input addresses manually** and **upload images** from their gallery.
- Display the **landmark's position directly within the addition screen** rather than requiring navigation to another page.
- Introduce a mechanism to **prevent** users from marking a landmark as "**Found**" unless they are physically near it.

### 5. User Control and Confirmation

- Add a "**Stop**" button to allow users to pause or exit a session without losing progress.
- Implement confirmation prompts before major actions, such as **starting** or **quitting** a session.
- Modify the "**Quit**" button functionality to prevent **accidental session termination** and loss of progress.
- Avoid using the **same icon** for different functions to maintain consistency across the interface.
- Improve the design of the "**End Session**" **screen** to better reflect the user's journey rather than referring to the experience as a "game" if it was not introduced as such.

## Conclusion

Implementing these changes will enhance usability, engagement, and accessibility, creating a smoother and more enjoyable user experience.

## 5.3.1 List of Violations

### 5.3.1.1 Smartphone + Touch

For a table view of the following violations, the [A4 Repository](#) contains the same information in a different view.

#### 1. Violation 1:

- *Heuristic*: H1: Visibility of system status
- *Where*: Add landmark
- *What*: Button "Share current position" without feedback
- *Why*: The absence of visual or textual feedback (e.g., confirmation message or acquired address) leaves the user confused about whether the operation was successful.
- *Severity*: 2

#### 2. Violation 2:

- *Heuristic*: H1: Visibility of system status
- *Where*: Home, first access
- *What*: The user needs to click "Search" to find landmarks instead of seeing them directly on the home screen.
- *Why*: The system does not present the expected options or information, failing to provide clear visibility of available content or actions.
- *Severity*: 3

#### 3. Violation 3:

- *Heuristic*: H1-H6: Visibility of system status + Recognition rather than recall
- *Where*: Extra challenge popup
- *What*: The extra challenge popup does not open automatically when available. Instead, users must manually click on it.
- *Why*: The lack of an automatic popup reduces the visibility of extra challenges. Users are not immediately informed when new challenges are available, which makes it harder for them to engage with this feature without actively searching for it (H1). Users are required to remember to check for extra challenges. This increases cognitive load, as users must recall the need to manually open the popup rather than easily recognizing the opportunity when it arises (H6).
- *Severity*: 3

#### 4. Violation 4:

- *Heuristic*: H2 Match between system and the real world
- *Where*: Mission information page
- *What*: The "Next" button redirects users to the first landmark on the list
- *Why*: The label "Next" may mislead users into thinking it navigates to the next section of text

- *Severity:* 2
5. **Violation 5:**
- *Heuristic:* H2 Match between system and the real world
  - *Where:* Landmark riddle page
  - *What:* The "magnifying glass with a question mark" icon represents the riddle textbox on the page
  - *Why:* The icon lacks context and may not be immediately understood
  - *Severity:* 2
6. **Violation 6:**
- *Heuristic:* H2 Match between system and the real world
  - *Where:* Add landmark page
  - *What:* The image box allows users to upload a photo of a new landmark
  - *Why:* Without context, the image box may look more like a placeholder than an upload field
  - *Severity:* 2
7. **Violation 7:**
- *Heuristic:* H2: Match between system and real world
  - *Where:* Add landmark page
  - *What:* The "Share current position" button saves the user's current coordinates.
  - *Why:* The wording might mislead users into thinking their location is being shared in real time, rather than saved.
  - *Severity:* 2
8. **Violation 8:**
- *Heuristic:* H2: Match between system and real world
  - *Where:* Landmark found page
  - *What:* The thumbs-up and thumbs-down icons allow users to indicate whether a landmark has been found.
  - *Why:* These icons are commonly associated with "like" and "dislike," which may cause confusion.
  - *Severity:* 3–2
9. **Violation 9:**
- *Heuristic:* H2: Match between system and real world
  - *Where:* Home, searching for a new session
  - *What:* Flags appear on the map after starting a new session, representing routes.
  - *Why:* Flags are commonly associated with points of interest (landmarks) or destinations, not routes, leading to mismatched expectations.
  - *Severity:* 3

**10. Violation 10:**

- *Heuristic*: H1-H2: Visibility of system status + Match between system and real world
- *Where*: Home, after accepting a route
- *What*: After accepting a route, the flag changes to a checkmark (✓), leading users to believe they should click it to start navigating. Instead, they need to click a separate icon on the right.
- *Why*: This creates a mismatch between user expectations (H2) and actual functionality. Additionally, the system status is unclear, as the checkmark does not adequately communicate that the route is ready but must be started elsewhere (H1).
- *Severity*: 2

**11. Violation 11:**

- *Heuristic*: H3: User control and freedom
- *Where*: Mission information page
- *What*: The "show info page" function is missing.
- *Why*: After the page is viewed and the first landmark unlocked, users cannot return to the mission information page.
- *Severity*: 3

**12. Violation 12:**

- *Heuristic*: H3: User control and freedom
- *Where*: Add landmark page
- *What*: The "Add" button submits the proposed location to the app's back-end server.
- *Why*: Users cannot correct mistakes (e.g., a wrong landmark name) after submission.
- *Severity*: 3

**13. Violation 13:**

- *Heuristic*: H3: User control and freedom
- *Where*: Mission overview page
- *What*: The "remove mission" function is missing.
- *Why*: Once a mission is accepted, users cannot remove it from ongoing or completed missions.
- *Severity*: 4

**14. Violation 14:**

- *Heuristic*: H3: User control and freedom
- *Where*: Entire landmark riddles section
- *What*: Navigation functions for landmarks are missing.
- *Why*: If a user accidentally skips a landmark in the real world, they cannot access other landmarks.
- *Severity*: 4

**15. Violation 15:**

- *Heuristic*: H3: User control and freedom
- *Where*: Different landmark windows
- *What*: The back arrow always leads to the main map page.
- *Why*: The user must have the freedom to return both to the tab before and to the homepage. The arrow cannot only lead back to the first page.
- *Severity*: 4

**16. Violation 16:**

- *Heuristic*: H3: User control and freedom
- *Where*: In the screens of the game session accepted
- *What*: There is no "Stop" button to allow the user to halt the game session and to begin another one without having the first one pending
- *Why*: The user does not have the control to stop the activity
- *Severity*: 2

**17. Violation 17:**

- *Heuristic*: H4: Consistency and standards
- *Where*: Main map screen
- *What*: When clicked, the magnifying glass icon shows the landmarks of a specific zone.
- *Why*: The magnifying glass icon suggests "search within a specific zone" rather than "scan the entire area."
- *Severity*: 2

**18. Violation 18:**

- *Heuristic*: H4: Consistency and standards
- *Where*: Main map screen
- *What*: Clicking the map pin displays a group of landmarks from a specific area.
- *Why*: Map pins are generally used to indicate a single location, not a group of locations.
- *Severity*: 2

**19. Violation 19:**

- *Heuristic*: H4: Consistency and standards
- *Where*: Pop-up messages
- *What*: The upper-right arrow is used to return to the map.
- *Why*: While consistent, this does not follow established standards, as an arrow usually indicates "go back to the previous page."
- *Severity*: 3

**20. Violation 20:**

- *Heuristic*: H4: Consistency and standards
- *Where*: Main map screen
- *What*: The "magnifying glass" button's position and size.

- *Why:* Its ambiguous placement could lead users to believe it represents a secondary action rather than the primary operation of the app.
- *Severity:* 3

**21. Violation 21:**

- *Heuristic:* H4: Consistency and standards
- *Where:* Main map screen
- *What:* The symbol for an accepted mission is a map pin with a checkmark. position and size.
- *Why:* This symbol is commonly associated with a completed task, which could confuse users.
- *Severity:* 3

**22. Violation 22:**

- *Heuristic:* H4: Consistency and standards
- *Where:* Evaluation window 'I found the landmark'
- *What:* The two buttons with thumbs up and thumbs down.
- *Why:* Usually the thumbs down and up are used to say 'like'/'dislike'. Here they are used to say 'this is the landmark I found' / 'this is not the landmark'.
- *Severity:* 3–2

**23. Violation 23:**

- *Heuristic:* H4: Consistency and standards
- *Where:* Map
- *What:* Landmarks area flag
- *Why:* A flag icon is commonly associated with a final destination or checkpoint, not multiple places to explore. This inconsistent usage can confuse users, leading them to misinterpret the meaning of the icon.
- *Severity:* 2

**24. Violation 24:**

- *Heuristic:* H5: Error Prevention
- *Where:* Add landmark page
- *What:* The "Add" button submits the proposed location to the app's back-end server.
- *Why:* Users can add an incomplete landmark if either or both required fields (name or position) are left blank.
- *Severity:* 3

**25. Violation 25:**

- *Heuristic:* H4: Consistency and standards
- *Where:* Add landmark
- *What:* Camera symbol to add a photo

- *Why:* The image for adding a photo is not very clear (it looks like a photo already inserted). It would have been more intuitive to use an icon with a camera and a '+' symbol to represent the action.
- *Severity:* 2

**26. Violation 26:**

- *Heuristic:* H5: Error Prevention
- *Where:* Trophy page (if a challenge is completed)
- *What:* The "End" button takes users to the next challenge.
- *Why:* Clicking "End" instead of "Continue" removes access to the unique landmark, and this action is not clearly indicated.
- *Severity:* 4–3

**27. Violation 27:**

- *Heuristic:* H5: Error Prevention
- *Where:* Add landmark
- *What:* Clicking the ADD button no popup
- *Why:* Clicking on 'Add' does not display a confirmation popup for an irreversible operation. The system should prevent the user from making mistakes by providing a confirmation step, such as a popup asking: 'Are you sure you want to add this item?
- *Severity:* 3

**28. Violation 28:**

- *Heuristic:* H6: Recognition rather than recall
- *Where:* Map
- *What:* After accepting a mission, it is no longer possible to refuse it.
- *Why:* The user must be given the possibility of being able to refuse the mission or not complete it.
- *Severity:* 4–2

**29. Violation 29:**

- *Heuristic:* H5: Error Prevention
- *Where:* Popup mini tutorial
- *What:* Can no longer be recovered if closed.
- *Why:* If you accidentally close the window with the explanations, without perhaps reading, there is no way to re-read or re-open the window. One is left without instructions
- *Severity:* 3

**30. Violation 30:**

- *Heuristic:* H7: Flexibility and efficiency of use
- *Where:* Map
- *What:* After completing the mission, a placeholder appears with a cup

- *Why:* A placeholder with a cup appears in the landmark area, is not clickable and it is not possible to review the places explored and the actions just performed.
- *Severity:* 2

**31. Violation 31:**

- *Heuristic:* H6: Recognition rather than recall
- *Where:* Different landmark windows
- *What:* Magnifying glass icon to indicate a clue.
- *Why:* Without a textual label such as "Riddle"/"Clue", the user has to interpret the meaning of the icon or remember from the context that it represents a clue in order to find the landmark. This increases the cognitive load, especially for new users.
- *Severity:* 2

**32. Violation 32:**

- *Heuristic:* H8: Aesthetic and minimalist design
- *Where:* Landmark riddle page
- *What:* The "magnifying glass with a question mark" icon represents the riddle textbox on the page.
- *Why:* The icon is unnecessarily large and serves no function.
- *Severity:* 2

**33. Violation 33:**

- *Heuristic:* H7: Flexibility and efficiency of use
- *Where:* Map navigation
- *What:* The map cannot be freely explored.
- *Why:* The lack of flexibility in navigating the map reduces the user's motivation to continue exploring. Once nearby landmarks are completed, users are unable to easily discover new places to visit, leading to a decrease in their desire to explore further.
- *Severity:* 3

**34. Violation 34:**

- *Heuristic:* H8: Aesthetic and minimalist design
- *Where:* Mission information page
- *What:* The information text is excessively long.
- *Why:* Lengthy text can cause users to lose focus.
- *Severity:* 3

**35. Violation 35:**

- *Heuristic:* H8: Aesthetic and minimalist design
- *Where:* Add landmark page
- *What:* The "Position" label above the "Share current position" button
- *Why:* The label is redundant, as the button already specifies the action.
- *Severity:* 2

**36. Violation 36:**

- *Heuristic*: H8: Aesthetic and minimalist design
- *Where*: Completing challenges
- *What*: The interface is cluttered with too many question marks and visual placeholders.
- *Why*: Non-functional elements distract from the main objectives.
- *Severity*: 1

**37. Violation 37:**

- *Heuristic*: H8: Aesthetic and minimalist design
- *Where*: Home page
- *What*: Search button to start playing
- *Why*: A small button for an important action such as "Start looking for landmarks" does not give the right emphasis. The user may not notice it easily, compromising usability. Such an important button should be highly visible and prominent to guide the user.
- *Severity*: 2

**38. Violation 38:**

- *Heuristic*: H10: Help and documentation
- *Where*: Main map screen
- *What*: The camera button is disabled for unregistered users.
- *Why*: There is no feedback when clicking the button, leaving unregistered users unaware of why it is blocked. - The camera button is disabled because it requires login, but the system does not provide any explanation or guidance, the user does not receive any instructions on how to solve the problem (e.g. a message explaining 'Please login to activate the camera')
- *Severity*: 2–2

**39. Violation 39:**

- *Heuristic*: H9: Help user recognize, diagnose, recover errors
- *Where*: Task 3, expert mode, modifying a landmark
- *What*: It is not possible to delete or modify a landmark after it has been accepted.
- *Why*: Users cannot correct mistakes or change their minds.
- *Severity*: 3

**40. Violation 40:**

- *Heuristic*: H10: Help and documentation
- *Where*: Main map screen
- *What*: Landmarks can only be viewed by clicking the flag button on the right.
- *Why*: New users may not know this function exists, as it is not explained anywhere.
- *Severity*: 3

**41. Violation 41:**

- *Heuristic*: H10: Help and documentation
- *Where*: Landmark riddle page
- *What*: The "target with bow" icon opens the "extra challenge" box.
- *Why*: Its function is unclear to new users, as it is not explained.
- *Severity*: 2

**42. Violation 42:**

- *Heuristic*: H10: Help and documentation
- *Where*: Different landmark windows
- *What*: Presence of the extra challenge.
- *Why*: Nowhere is it explained that it is possible to perform an extra challenge for the accepted mission, which unlocks other content. The user may lose some content of the experience.
- *Severity*: 3

**43. Violation 43:**

- *Heuristic*: H10: Help and documentation
- *Where*: Map
- *What*: After accepting the mission, a flag appears with a "1" and a tick.
- *Why*: By accepting the mission a tick appears on the selected landmark area and a flag with a 1 in the upper right corner. It is not clear which of the two icons to proceed from and what to do.
- *Severity*: 2

**44. Violation 44:**

- *Heuristic*: H10: Help and documentation
- *Where*: Every screen
- *What*: There is no button or feature to assist users by providing guidance on how to play if they are unfamiliar with the game
- *Why*: Without a guide, the user might not know what actions to take or where to interact.
- *Severity*: 1

**45. Violation 45:**

- *Heuristic*: HN: Non-heuristic issue
- *Where*: Evaluation window ("I found the landmark")
- *What*: I click my thumb down.
- *Why*: What happens after I say 'that the place is not the landmark'?
- *Severity*: 3

### 5.3.1.2 Smartwatch + Touch

#### 1. Violation 1:

- *Heuristic*: H1: Visibility of system status
- *Where*: Landmark confirmation page (moderate task)
- *What*: Only one hint is displayed at a time, with a navigation arrow to view the others. It is not immediately clear that there are three hints in total
- *Why*: The system does not clearly communicate the total number of available hints, leaving users unaware of additional information they can access
- *Severity*: 1

#### 2. Violation 2:

- *Heuristic*: H1: Visibility of system status
- *Where*: Landmark confirmation page (moderate task)
- *What*: There is no feedback indicating that the landmark has been successfully added after the user confirms.
- *Why*: Users might be unsure whether their action was successful, leading to confusion or repeated attempts to add the landmark.
- *Severity*: 2

#### 3. Violation 3:

- *Heuristic*: H2: Match between system and the real world
- *Where*: Landmark confirmation page, third hint (moderate task)
- *What*: The "Quit" button may be unclear, as users might think it closes the hints but could interpret it as leaving the game entirely
- *Why*: The button is leading to confusion about whether they are exiting the hints or abandoning the game
- *Severity*: 2

#### 4. Violation 4:

- *Heuristic*: H2: Match between system and the real world
- *Where*: Main view
- *What*: The scrollbar on the right
- *Why*: It is used to move from the "Start" button to the "Add Landmark" button, which is an unconventional use of a scrollbar, leading to confusion.
- *Severity*: 3

#### 5. Violation 5:

- *Heuristic*: H3: User Control and freedom
- *Where*: "Session" view
- *What*: there is no way to move from a landmark to another
- *Why*: Users may miss a landmark in the real world but still want to proceed to the next one
- *Severity*: 2

**6. Violation 6:**

- *Heuristic*: H3: User control and freedom
- *Where*: "Session" view
- *What*: Clicking "Quit" immediately closes the session
- *Why*: This can cause users to lose all progress if clicked accidentally
- *Severity*: 4

**7. Violation 7:**

- *Heuristic*: H3: User control and freedom
- *Where*: "Choose Mode" view
- *What*: Clicking the "Play" button immediately starts the session
- *Why*: If the user selects the wrong mode, they must quit and restart the session to correct it.
- *Severity*: 3

**8. Violation 8:**

- *Heuristic*: H4: Consistency and standards
- *Where*: "End Session" view
- *What*: The symbol used for the button to close the page
- *Why*: This symbol is the same one used on other pages to confirm actions, creating confusion due to inconsistent usage across different contexts
- *Severity*: 1

**9. Violation 9:**

- *Heuristic*: H4: Consistency and standards
- *Where*: "End Session" view
- *What*: The word "game" in the central label
- *Why*: The experience was not introduced as a game at the start, yet here it states that the game is completed, leading to inconsistency in the messaging.
- *Severity*: 1

**10. Violation 10:**

- *Heuristic*: H4: Consistency and standards
- *Where*: "Session" view
- *What*: The arrows used to scroll the page
- *Why*: These arrows differ from those on the "Choose Mode" view, leading to inconsistency in design
- *Severity*: 2

**11. Violation 11:**

- *Heuristic*: H4: Consistency and standards
- *Where*: "Choose Mode" view
- *What*: The button to start the session
- *Why*: It is labelled "Play" here but "Start" on the previous page, causing terminology inconsistency.

- *Severity:* 2

**12. Violation 12:**

- *Heuristic:* H4: Consistency and standards, H7 Flexibility and efficiency of use
- *Where:* Landmark confirmation page
- *What:* On the first hint page, there is a button to mark that the user has found the landmark, but on the last hint page, this button is missing
- *Why:* The inconsistency between the pages creates confusion, as users expect the same options to be available throughout the process
- *Severity:* 3

**13. Violation 13:**

- *Heuristic:* H5: Error prevention
- *Where:* "Add Landmark" view
- *What:* Users must figure out how the function works by trial and error, which is not straightforward due to the complexity of the landmark selection process
- *Why:* If the search result is incorrect, the user must go back and retry multiple times, which can lead to frustration and disengagement from the procedure
- *Severity:* 4

**14. Violation 14:**

- *Heuristic:* H5: Error prevention
- *Where:* "Session" view
- *What:* The "+" button
- *Why:* The button is too small, increasing the likelihood of accidental clicks.
- *Severity:* 2

**15. Violation 15:**

- *Heuristic:* H6: Recognition rather than recall
- *Where:* "Choose Mode" view
- *What:* Missing page title
- *Why:* The user cannot easily identify the purpose of this page without guessing
- *Severity:* 2

**16. Violation 16:**

- *Heuristic:* H6: Recognition rather than recall
- *Where:* "Session" view
- *What:* The "+" button
- *Why:* At this stage, users may not recall that the "+" symbol was used for adding landmarks on the main page. This lack of clarity makes it difficult for users to identify the button's function.
- *Severity:* 2

**17. Violation 17:**

- *Heuristic:* H7: Flexibility and efficiency of use, H5 Error Preventions
- *Where:* Difficulty selection page (simple task)

- *What:* The back button is too small, making it difficult for users to tap
- *Why:* The small size of the back button reduces usability, especially on a smartwatch where precise input can be challenging
- *Severity:* 3

**18. Violation 18:**

- *Heuristic:* H7: Flexibility and efficiency of use
- *Where:* Add new landmark page (complex task)
- *What:* Users must manually enter the name of the landmark they want to add
- *Why:* Typing on a smartwatch can be challenging due to the small screen size, reducing efficiency and increasing the likelihood of errors.
- *Severity:* 3

**19. Violation 19:**

- *Heuristic:* H7: Flexibility and efficiency of use
- *Where:* Landmark confirmation page (moderate task)
- *What:* When the user clicks on "X" to close, the interface simply closes without offering suggestions for similar or nearby landmarks to select
- *Why:* Providing a list of similar or nearby landmarks would reduce the user's effort and improve efficiency, especially given the challenges of manual input on a smartwatch
- *Severity:* 2

**20. Violation 20:**

- *Heuristic:* H7: Flexibility and efficiency of use
- *Where:* During an activity, "Add Landmark" button (moderate task)
- *What:* The button to add a new landmark is too small, making it difficult to tap
- *Why:* On a smartwatch, precise interactions are challenging, and a small button can lead to frustration and inefficiency during an activity
- *Severity:* 3

**21. Violation 21:**

- *Heuristic:* H8: Aesthetic and minimalist design
- *Where:* On the "Choose Mode" view
- *What:* The app name at the top
- *Why:* It wastes valuable screen space (critical on a smartwatch) and distracts the user with irrelevant information
- *Severity:* 2

**22. Violation 22:**

- *Heuristic:* H8: Aesthetic and minimalist design
- *Where:* "Choose Mode" view - "Hard Mode"
- *What:* The text describing hard mode
- *Why:* The text is excessively long, resulting in a small font size on a smartwatch, making it difficult to read and taking up too much space

- *Severity:* 3

**23. Violation 23:**

- *Heuristic:* H8: Aesthetic and minimalist design
- *Where:* "Session" view
- *What:* the arrows button to scroll the page
- *Why:* These buttons duplicate the functionality of the scrollbar, wasting space and potentially confusing users
- *Severity:* 1

**24. Violation 24:**

- *Heuristic:* H10: Help and documentation
- *Where:* Throughout the application
- *What:* There is little documentation or guidance to help users navigate the app.
- *Why:* The lack of clear instructions or help sections means users may struggle to understand certain features or how to complete tasks effectively, leading to confusion or errors.
- *Severity:* 3

**25. Violation 25:**

- *Heuristic:* H10: Help and documentation
- *Where:* "Add landmark" view
- *What:* The user is immediately directed to the procedure without an explanation of how it works
- *Why:* Users must figure out how the function works by trial and error, which is not straightforward due to the complexity of the landmark selection process.
- *Severity:* 2

**26. Violation 26:**

- *Heuristic:* HN: Non-heuristic issue
- *Where:* "Found Landmark" view
- *What:* The location and the image of the landmark
- *Why:* Displaying both the location and image together on a single page results in them being too small to view clearly, given the limited screen size of a smartwatch
- *Severity:* 2

## 5.4 Selection

After a careful analysis of the pros and cons of both prototypes, we decided to opt for the **smartphone prototype**. This decision was strongly influenced by the undeniable fact that all potential users are more likely to own a smartphone than a smartwatch.

Prototype Number	# of Evaluators(*)	# of Unique Violations	Total Severity	# of Unique Violations/# of Evaluators	Total Severity/# of Unique Violation
1	4	45	115.5	<b>11.25</b>	<b>2.56</b>
2	2	29	67.5	<b>14.5</b>	<b>2.32</b>

When two evaluators gave the same violation different numbers for severity, the mean value was used (e.g., if one evaluator gave 3 and another 4  $\Rightarrow \frac{3+4}{2} = 3.5$  was used for counting the total severity)

Therefore, the number of violations per evaluator favored the smartphone prototype, with a score of 11.25 compared to 14.5 for the smartwatch prototype. Lastly, the target users' preference and inclination to use a smartphone played a crucial role in our decision.

During the evaluation process, no features from the smartwatch prototype were switched to the smartphone prototype.

(\*): As a side note, another key factor influencing our decision was that, for the smartwatch prototype, only two out of the three expected evaluations were submitted, with one evaluator failing to provide feedback. This not only limited our ability to conduct meaningful comparisons but also resulted in fewer data points compared to the smartphone prototype, reducing our ability to properly analyze and interpret the results.

## 6. Medium to High-Fidelity Prototype

We decided to employ the suggested and high-versatile tool Figma to represent the main screens that represents our application, while enhancing from the feedback received from the Heuristic Evaluation. Furthermore, Figma allows interactive tour from our new created application, and it is available with [this link](#).

Since the "First (Main, Map) Page" and the "Add (new landmark) Page" received the most violations, with 16 and 8 respectively, we decided to represent them. Additionally, many of these violations have a severity of 3 or 4.

### 6.1 Fixed Violations

- Violation 1:** A button with an icon has been implemented to retrieve the current location. To its right, a text box displays the shared position, informing the user of the action's success.
- Violation 6:** Provided a "+" button on the image box for uploading photo.
- Violation 7:** Modified text into "use your position" with an icon to better represent the actual functionality.
- Violation 9:** Changed flag icons with pin markers.
- Violation 10:** The icon now is the same as the available games, with a shade of gray.
- Violation 12:** Provided a confirmation pop-up after clicking the "add" button.
- Violation 13:** A trash icon was added in the current game session to allow the user to remove it.
- Violation 16:** Added a pop-up for the active game sessions in which the user can stop the current session.
- Violation 17:** Changed the magnifying glass icon to a more relevant icon.
- Violation 18:** Since the map pin marker is not directly associated with multiple locations but rather represents a starting point for each game session to find the n landmarks, we believe this does not constitute a valid violation.
- Violation 21:** Modified the symbol for an accepted game session into the same icon as the available games, with a shade of gray.
- Violation 23:** Changed flag icons with pin markers.
- Violation 24:** Invalidate the "Add" button if the required fields are empty.
- Violation 25:** Added a "+" button on the Image box for adding the image.
- Violation 27:** Implemented a confirmation popup after clicking "Add" button.
- Violation 28:** Added an option to remove any active game from the list of game sessions.
- Violation 35:** Removed the redundant label "Position".
- Violation 39:** A warning popup will display to inform the user that the action is irreversible.

- Violation 40:** A button has been added in the top left corner to explain the functionalities of the three buttons on the right.
- Violation 43:** The "1" and the tick have been removed, the map pin marker is updated to become non-clickable after the user accepts the related game session, and two exclamation marks are added near the flag to indicate that a new game session has been added to the list of active sessions.
- Violation 44:** A button has been added in the top left corner to explain the functionalities of the three buttons on the right.

## 6.2 Plans for Addressing Remaining Violations

The hi-fi prototype will be designed to address the violations reported in the list above. The following changes will be made to the hi-fi prototype:

- **Violation 2:** The map will auto populate immediately after launching the app to avoid confusion about what to do in the app.
- **Violation 3:** To address this violation, we find that the automatic opening of the challenge window takes control away from the user. Instead, we will improve the '*Extra Challenge*' button to make it more intuitive by adding a label near the icon.
- **Violation 4:** We will change the button text into something more clear like "Play" or "Start" to avoid confusion.
- **Violation 5:** We will add the text "Riddle" near the icon to make it more clear.
- **Violation 8:** We will add a label near the landmark image with a question. For example, "Did you find the landmark?". This will make the thumbs icons more related to the action.
- **Violation 11:** We will address this issue by adding a new icon in the same interfaces where the hints are displayed. This will be the only way to show the game information (when starting a new game by default, this page will not be displayed anymore), reducing the amount of text shown to the user before starting the game.
- **Violation 14:** We will not address this violation, the game doesn't let you skip any landmark, you cannot find all of them but still, this doesn't soft lock the game.
- **Violation 15:** As with the violation above, the main goal is to discover new places and always look for the new. Allowing backtracking is also useless in this type of game, as the user will not find any new value by going to the previous section of the current game session.
- **Violation 19:** The app does not have upper-right arrows. We will address the *upper-left* arrow to be more consistent, using possibly an *upper-right* "cross" icon to indicate the closing of the popup.
- **Violation 22:** This violation was already addressed in the **Violation 8** as it was more pertinent as the violation was more related to the icon's meaning than the actual consistency in the app.
- **Violation 26:** We will address this violation by adding a warning to make clear to the user that ending the session will lock the unique landmark.

- **Violation 29:** Although the original behavior was to resume the last screen displayed in the session (this includes the tutorial), so no violation was really present. Now with the new button that shows the tutorial/information page from the solution of the **Violation 11**, the violation is still not relevant or, you may say, already solved.
- **Violation 30:** As the violation was to address task specific behavior, this one was external to that. We will not address this violation.
- **Violation 31:** We have already addressed this violation in the **Violation 5**.
- **Violation 32:** The icon dimension in the low-fi prototype should not be considered a violation. We will not address this violation.
- **Violation 33:** This violation is unfortunately incorrect, the map is actually free to explore by interacting with the real world, the user can move freely in the real world and the map will update accordingly. Thus, we will not address this violation.
- **Violation 34:** We will not address this violation, as the task described by the text is complex, and we think the length is justified.
- **Violation 36:** We will remove redundant elements from the interface.
- **Violation 37:** From the already addressed **Violation 2** now this button is less important than before, so we think that now it has the right dimension for its importance.
- **Violation 38:** We will add a new popup to inform the users that they need to log in to add new landmarks.
- **Violation 41:** We already addressed this violation in the **Violation 3**.
- **Violation 42:** We will add a text informing the user what the extra challenge does.
- **Violation 45:** The end game screen shows the number of landmarks found, this was not implemented during the low-fi prototype but was clearly stated during the evaluation by the facilitator. This screen will be implemented in the hi-fi prototype, but this violation will not help us to improve the interface.

## 7. High-Fidelity Prototype

### 7.1 Tools and Libraries Used

After thoroughly evaluating various development frameworks, we chose to build our application using **React Native** with **TypeScript**. This decision was primarily driven by the availability of essential libraries within React Native and its conceptual similarity to React, a framework we had extensively studied during the Web Applications course. Furthermore, TypeScript was preferred over JavaScript due to its static typing, enhanced code maintainability, and improved developer experience. Its strong type system mitigates runtime errors, improves code readability, and facilitates advanced autocompletion and API integration, making it an optimal choice for developing structured and scalable applications.

To implement the user interface and core functionalities, we integrated several key libraries. **React Native Maps** was employed for interactive map visualization, enabling users to explore landmarks in real-time. One of the application's distinctive features is the **3D model synchronized with the camera**, which enhances user immersion. This was achieved through **React Three Fiber** and **Drei**, ensuring seamless integration between real-world positioning and

3D elements. Additionally, **React Native Modal** was employed to create intuitive modal windows, which serve as a central interaction element within the application.

For location-based services, we incorporated **Expo Location** and **React Native Geolocation Service**, ensuring accurate real-time tracking. **Expo Image Picker** was employed to allow users to upload or capture images directly within the app, while **Async Storage** was implemented to enable persistent data storage across sessions. These libraries were selected for their robustness, compatibility with **React Native**, and their ability to enhance the application's overall responsiveness and user experience.

Full code of Wanderlust prototype is available inside the [project repository](#).

## 7.2 Design Choices and Changes

In the transition from the **medium-fidelity prototype** to the current version, several **interface** elements have been refined to enhance **user interaction**. One of the most significant changes involves the use of **color**, which has played a crucial role in **design choices**, allowing us to implement **targeted improvements**, such as the ones described below.

The **first button**, which still represents a **flag**, has undergone a slight **redesign**. Additionally, the **visual cue** for newly added game sessions has changed: instead of using **exclamation marks**, the **interface** now employs a **flashing flag icon** to draw the user's attention more effectively. The **third button** at the bottom has been replaced with a **radar icon**, a choice that **better aligns with the system's functionality**.

The design of the **Info button** has also been updated: it now features an **animated popup** that emerges from the bottom. This change was made to **distinguish secondary functions** (such as the **Info button**) from the **primary ones**, which represent the three main tasks. Furthermore, some **Info buttons** have been embedded within specific **popups** to provide additional **explanations** and help users better understand certain **features**.

Additionally, we decided **not to include a tutorial popup** explaining how to play the **game session** during gameplay. Since the **interface design** was already quite **complex**, adding another popup could have overloaded the user experience. Instead, we opted for a **contextual message** that appears when the user presses the **Next** button, but is **outside the required range** for discovering the **landmark**.

Lastly, another key improvement concerns the **layout of the main buttons**, which have been **shifted slightly lower** to make it easier for users to interact with the **application using just one hand**.

Furthermore, a **preloading screen** was added after introducing the **3D player model** into the application. This prevents users from seeing the model while it is still loading and from encountering a buggy map due to incomplete loading. The preloading screen ensures that players can start the game only when the 3D model is fully ready.

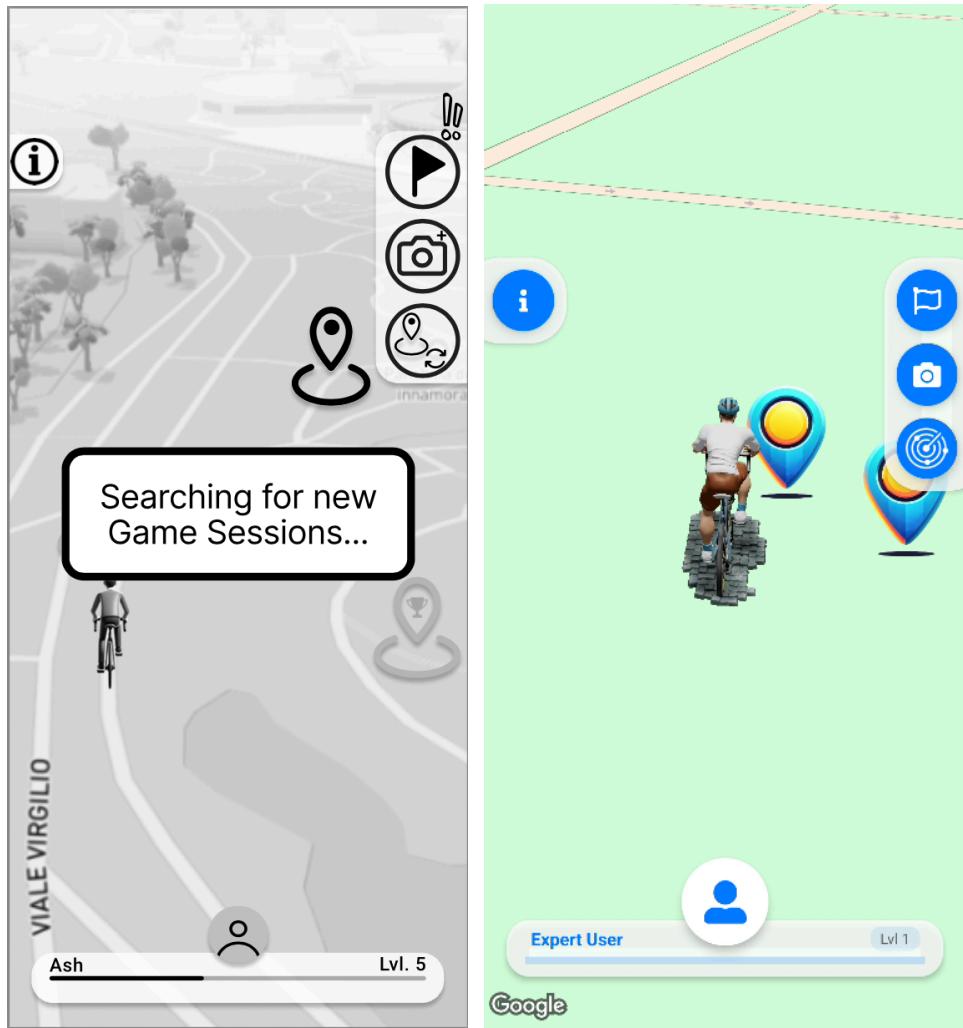


Figure 7.2.1 The *Select Game Session Popup* interface, allowing users to browse and add game sessions. The popup presents key details, such as the session name, a representative image, and the number of associated landmarks, ensuring an intuitive and engaging selection experience.

## 7.3 Significant Screens

### 7.3.1 Select Game Session Popup

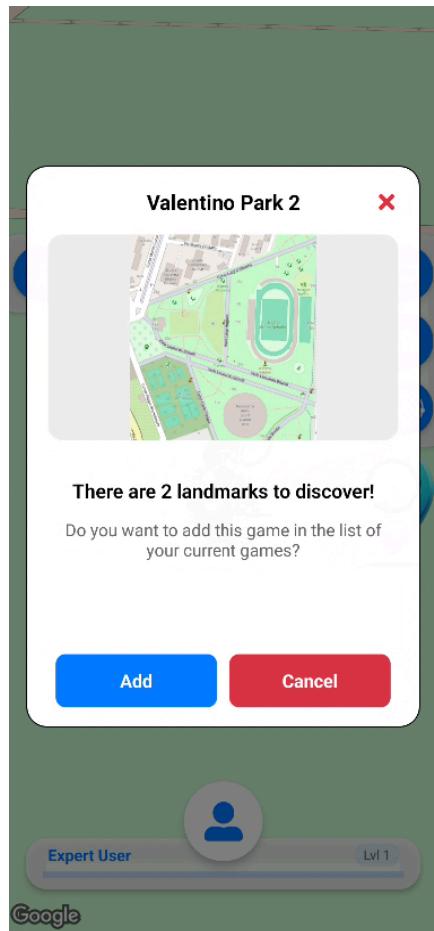


Figure 7.2 The *Select Game Session Popup* interface, allowing users to browse and add game sessions. The popup presents key details, such as the session name, a representative image, and the number of associated landmarks, ensuring an intuitive and engaging selection experience.

The **Select Game Session Popup** is a component of the application, embodying the core concept of dynamic and engaging gameplay by allowing users to add a new game session.

When accessing this popup, users are presented with an intuitive interface that displays essential details about the game session, including its name, a representative image of the path, and the number of landmarks associated with it. The interface is designed to be visually appealing and user-friendly, ensuring a seamless selection process.

Additionally, the popup provides users with two key actions: **adding** the game session to their list or **dismissing** the popup. To enhance usability, it includes a prominent **cancel button** for quick dismissal and an "Add" button for immediate session confirmation.

The **SelectGameSessionPopup** plays a crucial role in fostering engagement and providing a structured way to explore available game sessions. It integrates modern UI principles with effective functionality, making it a key interactive element in the application's user experience.

### 7.3.2 Game Session Popup

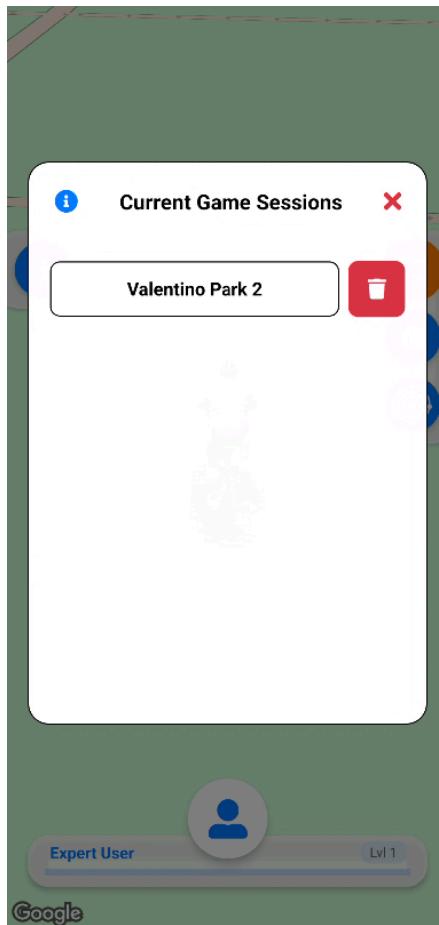


Figure 7.3 The *Game Session Popup* interface, enabling users to view, manage, and remove active game sessions. The popup features a structured list of sessions, deletion confirmation, an info modal for guidance, and an empty state message when no sessions are available, ensuring a smooth and intuitive user experience.

The **Game Session Popup** is a component that allows users to view, manage, and remove their active game sessions. It provides a user-friendly interface for interacting with game sessions, ensuring smooth navigation and intuitive functionality.

When the popup is displayed, users see a structured **list of active game sessions**, each represented with a name and a **delete button**. Users can select a session to interact with it or

remove it by pressing the trash icon. If a user attempts to delete a session, a **confirmation modal** appears to prevent accidental deletions. This confirmation popup asks the user if they are sure about deleting the session and provides two options: "Go Back!" to cancel the operation or "Delete" to proceed.

For a better user experience, the popup also includes an **information modal**, accessible through an info button in the header. This secondary modal provides guidance on managing game sessions, explaining their functionality and limitations.

If no active game sessions are available, an **empty state** is displayed, informing the user that no sessions are currently active. This section includes a motivational message and guidance on how to add a new session. The design of the component is structured with a **header section**, a **list container** for displaying sessions, and a **footer area** where confirmation popups and informational modals appear when needed. The styles ensure a modern and visually appealing layout, with proper spacing, button feedback, and structured alignment. Additionally, the integration of `AsyncStorage` hints at potential future functionality, such as saving session states persistently across app restarts.

### 7.3.3 Landmark and Unique Landmark Popup

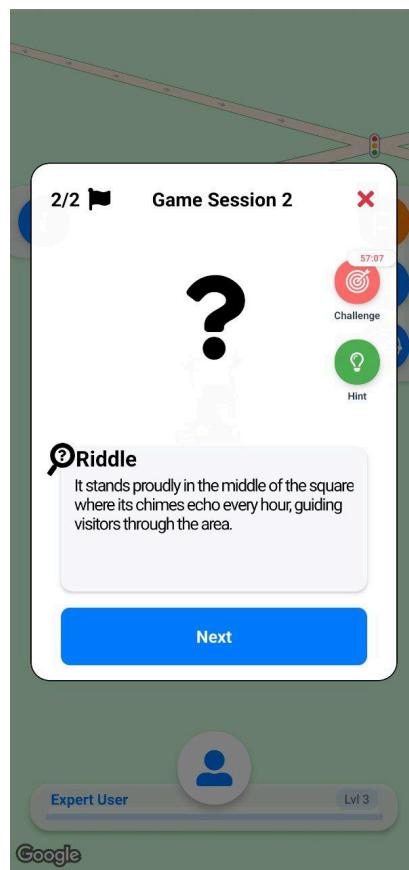


Figure 7.4 The *Landmark Popup* interface, guiding users through structured progression in a game session. It displays hints and challenges, verifies geographical proximity, manages user progress, and includes an extra challenge mode with a countdown timer, ensuring an engaging and dynamic gameplay experience.

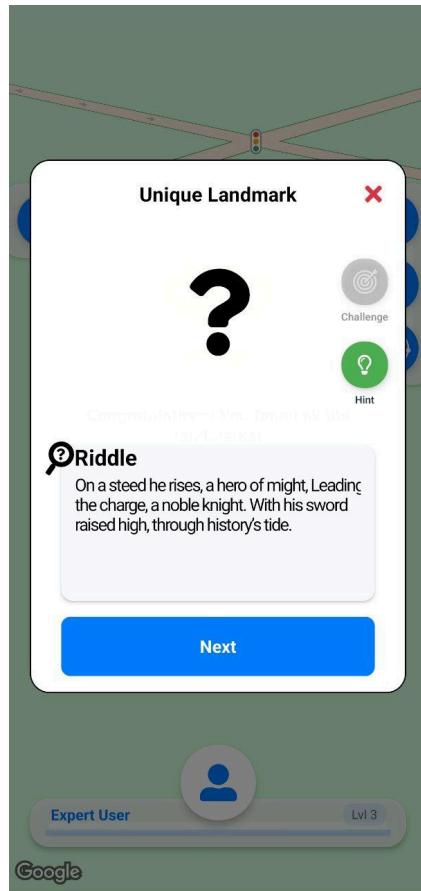


Figure 7.5 The *Unique Landmark Popup* interface, designed for standalone landmarks outside structured game sessions. It enables one-time interactions with unique points of interest, provides additional hints, and includes an exit confirmation popup to prevent accidental dismissals.

The **Landmark Popup** and **Unique Landmark Popup** are two essential components in the application, enabling users to interact with landmarks dynamically.

The **Landmark Popup** is a key interactive element that facilitates structured progression through a series of landmarks in a game session. When a user encounters a landmark, the popup displays relevant information, including hints and the challenge for the current game session. It verifies the user's geographical proximity using the Haversine formula, ensuring they are within an acceptable distance before allowing interaction. Additionally, an **extra challenge mode** is integrated, such as a limited time frame for discovering all landmarks, with a countdown timer that persists across sessions using *AsyncStorage*. The popup also manages user progress, marking landmarks as found and updating their status accordingly. A confirmation popup appears when a user completes an interaction, ensuring deliberate actions and minimizing accidental selections.

The **Unique Landmark Popup** is designed for single, independent landmarks that do not belong to a structured game session. Unlike the Landmark Popup, this component focuses on one-time landmark interactions, allowing users to engage with unique points of interest. Users can access additional hints if needed, and an exit confirmation popup prevents accidental dismissals.

While both components serve similar purposes, their design and functionality differ significantly. The **Landmark Popup** manages multiple landmarks in a sequence, enforces time-based challenges, and maintains session persistence, whereas the **Unique Landmark Popup** operates independently, focusing on singular landmark experiences without progression tracking. Both components incorporate user-friendly UI elements, real-time proximity validation, and confirmation modals to ensure smooth interaction and engagement.

#### 7.3.4 Confirmation Landmark and Unique Landmark Popup

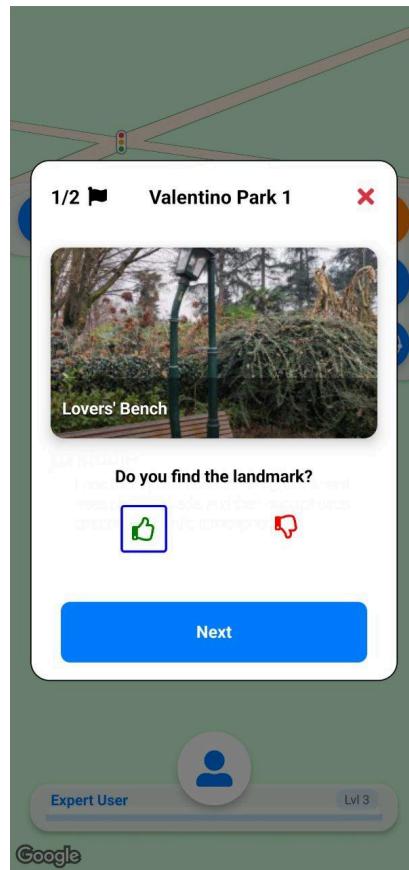


Figure 7.6 The *Confirmation Landmark Popup* interface, serving as a validation step within a structured game session. It prompts users to confirm landmark discovery, updates game progress, and triggers the *End Game Session Popup* when the final landmark is reached.

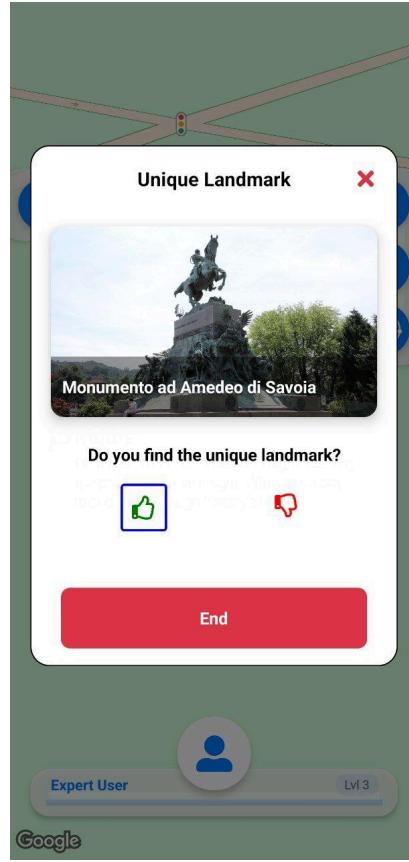


Figure 7.7 The *Confirmation Unique Landmark Popup* interface, designed for standalone landmark interactions outside structured game sessions. It allows users to confirm individual discoveries, includes an exit confirmation to prevent accidental dismissals, and updates the session state to maintain an accurate log of confirmed landmarks.

The **Confirmation Landmark Popup** and **Confirmation Unique Landmark Popup** are essential validation steps in the application, ensuring that users explicitly confirm their landmark discoveries before updating game progress.

The **Confirmation Landmark Popup** is a critical validation step within a structured game session. When a user reaches a landmark, this popup displays the landmark's name and image, prompting the user to confirm whether he found it by selecting "Yes" or "No" via **thumbs up** or **thumbs down**. If the user confirms the discovery, the system updates the game progress, marking the landmark as found and potentially awarding experience points. In cases where the landmark is the final one in a session, the popup triggers the **EndGameSessionPopup** to finalize the session and update its completion status. A key feature of this component is the use of *AsyncStorage* to track the last opened popup, ensuring seamless persistence across app sessions. If the user exits the game and reopens it, the application restores the last state, preventing progress loss. The component also ensures structured progression by disabling the "Next" button until a selection is made, reducing accidental interactions and maintaining game integrity.

The **Confirmation Unique Landmark Popup** operates similarly to the Confirmation LandmarkPopup but is specifically designed for standalone landmark interactions outside of structured game sessions. Unlike structured sessions, confirming a unique landmark does not trigger session-wide progression but instead updates the status of that individual discovery. One notable feature of this component is its **exit confirmation mechanism**. If a user attempts to close the popup without making a selection, a secondary confirmation appears, ensuring that they acknowledge their decision before exiting. This prevents accidental dismissals and reinforces deliberate gameplay actions. The component also updates the session state to reflect whether the unique landmark has been confirmed or not, maintaining an accurate log of user discoveries.

While both popups serve as confirmation mechanisms, their scope and functionality differ. The **ConfirmationLandmarkPopup** is part of a structured game session, managing multiple landmarks in sequence, while the **ConfirmationUniqueLandmarkPopup** focuses on isolated landmark interactions without structured progression.

### 7.3.5 End Game Session Popup

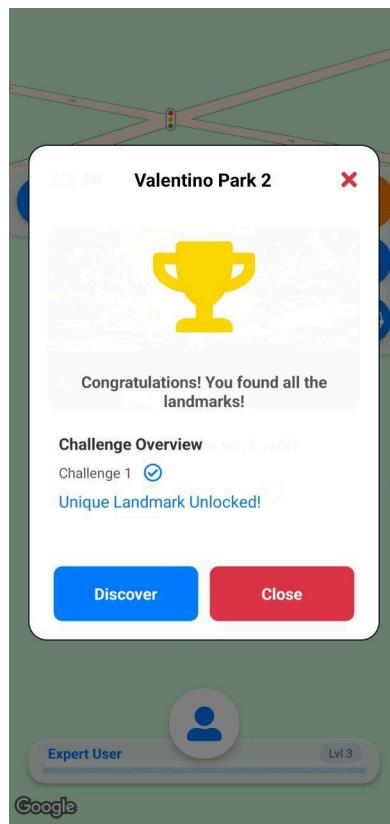


Figure 7.8 The *End Game Session Popup* interface, summarizing game session completion, rewards, and next steps. It provides visual feedback on progress, indicates unlocked challenges, and offers action buttons for discovering unique landmarks or closing the session. An exit confirmation prevents accidental dismissals, ensuring a structured and engaging conclusion.

The **End Game Session Popup** is a component that provides users with a summary of their game session completion, rewards, and potential next steps. It ensures a structured conclusion to a game session by displaying the final results, handling experience point allocation, and guiding the user toward any additional unlocked challenges.

When the popup appears, it presents the game session name along with a visual indicator of success, such as a trophy icon that changes color depending on whether all landmarks have been found. A congratulatory or motivational message informs the user of their progress, reinforcing engagement and encouraging further participation. Below this, a challenge overview section indicates whether an extra challenge has been successfully completed. If all conditions are met, the popup notifies the user that a **challenge** has been unlocked, offering an additional discovery opportunity.

The user is provided with action buttons that allow them to either proceed with the **Unique Landmark** or close the popup, effectively ending the session. If a unique landmark is available, “discover” button transitions the user to a dedicated interface for exploring the new landmark. On the other hand, pressing the “Close” button finalizes the session and removes it from the active list.

To prevent accidental exits, the popup includes an exit confirmation mechanism. If the user attempts to leave without engaging with the unique landmark, a confirmation modal appears, warning them that they will miss the opportunity. This secondary popup provides clear choices: the user can either return and proceed with the unique challenge or confirm their exit to close the session definitively.

### 7.3.6 Add Landmark Popup

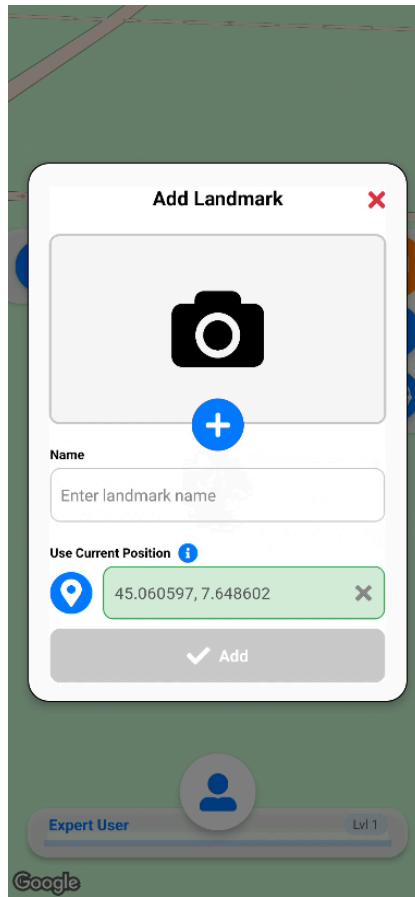


Figure 7.9 The *Add Landmark* popup, enabling users to contribute new landmarks to the application's database, fostering community-driven exploration. It provides an intuitive interface for adding a name, photo, and GPS location, ensuring accuracy through validation mechanisms and real-time feedback to enhance usability.

The **Add Landmark** popup is a pivotal component of the application, embodying the core concept of **community-driven exploration** by enabling users to add new landmarks while fostering engagement and collaboration. Through this feature, users contribute directly to the application's dynamic environment, enriching the “database” of locations and enhancing the gameplay experience for others.

When accessing this popup, users are presented with an intuitive interface designed to collect essential details about a landmark, including its name, a photo, and its geographical location. Photos can be uploaded either by capturing a new image with the device's camera or selecting one from the gallery, ensuring flexibility to meet different user preferences. Additionally, the popup allows users to automatically detect and display their real-time GPS coordinates, ensuring accuracy and convenience.

This screen is intrinsically tied to the complex task: *"Add new landmarks to be used in subsequent games by other users."* To ensure a seamless experience, the popup incorporates

robust validation mechanisms, such as verifying that the landmark name meets specific criteria and confirming the presence of a photo and GPS coordinates before submission. Real-time visual feedback, such as checkmarks and highlighted fields, guides the user through the process, minimizing errors and improving usability.

### 7.3.7 Preloaded Screen



Figure 7.10 The Preloading screen added to prevent users from seeing the incomplete 3D model and buggy map during loading.

The preloading screen was added after introducing the 3D player model into the application. This prevents users from seeing the model while it is still loading and from encountering a buggy map due to incomplete loading. The preloading screen ensures that players can start the game only when the 3D model is fully ready.

### 7.3.8 Map Screen

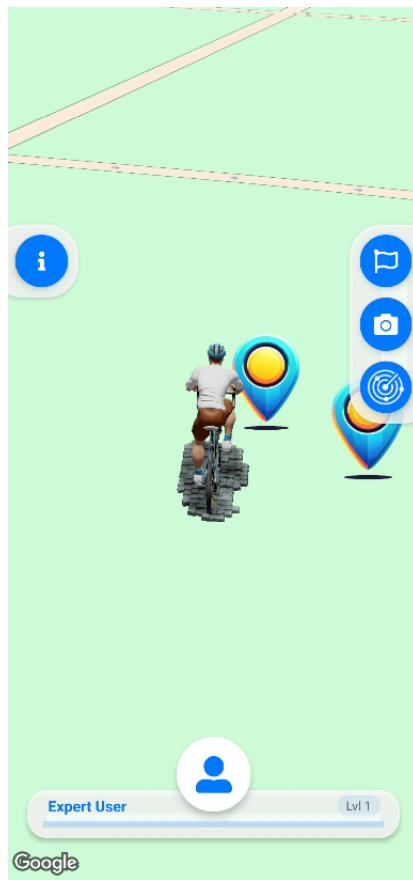


Figure 7.11 The **Map Screen** displaying the interactive map with real-time user tracking, game session markers, and key UI elements for navigation, exploration, and landmark creation.

The **Map Screen** serves as the central hub of the application, where users interact with the core functionalities related to exploration and game sessions. This screen seamlessly integrates geolocation services, dynamic session management, and interactive 3D visualization to provide an engaging and immersive experience.

When users access the **Map Screen**, they are presented with an interactive map that displays **game sessions**. The map is built using *react-native-maps* and is continuously updated based on the user's real-time location. The game sessions are visualized through map markers, allowing users to engage with them interactively.

One of the most striking features of this screen is the 3D Player model, which is synchronized with the user's position and map view. By utilizing Player 3D, the application accurately represents the user's movement within the environment, offering a more immersive and interactive experience. The model dynamically updates based on GPS coordinates and orientation to ensure precise positioning and smooth performance. Realistic lighting was

achieved using an ambient light for global illumination, while a direct light source from above simulates natural daytime outdoor lighting conditions.

The **game session system** enables users to discover, accept, and complete various exploration challenges. The application provides a **progression system**, where users earn experience points for completing challenges and unlocking new content. Additionally, a **sonar-based exploration tool** allows users to scan the surroundings for available game sessions. If a new session is discovered, an animation visually indicates its appearance on the map.

To enhance usability, the interface includes:

- **Dynamic popups** for game session selection and interaction.
- **Real-time user tracking** with location updates.
- **Visual feedback** through animations, confirmations, and progress indicators.
- **Persistent state management** via `AsyncStorage`, ensuring that users' progress is saved and reloaded across sessions.

The **Map Screen** is fundamental to the application's design, as it brings together exploration, interaction, and contribution within a single interface. By integrating **3D visualization, geolocation services, and community-driven features**, it fosters a unique and immersive outdoor experience.

## 7.4 Standards, Constraints and Visual Design

To ensure a seamless and consistent user experience across different mobile devices, we adopted a **responsive design approach** by leveraging the `wp`, `hp`, and `normalize` functions. These utilities allow us to dynamically adjust the width, height, and font sizes of various components, ensuring that the user interface remains well-proportioned regardless of screen size or resolution. Instead of relying on hardcoded dimensions, which can lead to layout inconsistencies, we implemented a **scalable UI** where elements adapt fluidly to different screen densities.

By utilizing **width percentage (`wp`) and height percentage (`hp`)**, components maintain relative proportions across devices, preventing elements from appearing too compressed on smaller screens or excessively large on larger ones. Similarly, the **normalize function** is applied to text and icons, ensuring that font sizes remain legible and aesthetically balanced across varying display densities. This approach eliminates the common issue of text appearing disproportionately small on high-resolution screens or too large on low-resolution ones. Additionally, spacing, margins, and paddings are computed dynamically to maintain a visually harmonious layout on all devices.

The **color scheme** follows a structured and coherent palette that enhances usability while maintaining a visually engaging experience. The **primary color** (`#007BFF`) was chosen because blue is commonly associated with reliability, trust, and clarity. It provides a **strong visual affordance**, making interactive elements such as buttons and highlights easily distinguishable while maintaining a professional and modern appearance. Additionally, blue is a **neutral and non-intrusive** color, reducing cognitive load and ensuring that key interactive elements remain intuitive **without overwhelming the user**.

For **warning actions and exit buttons**, the **color** (`#DC3545`) is used to reinforce their importance. As red is naturally associated with urgency and caution, it serves as a **strong visual cue for critical actions**, such as closing a session or confirming an irreversible choice. Similarly, red is applied to **error messages** to instinctively draw attention to issues requiring correction.

To provide **intuitive feedback**, the **color** (`#4CAF50`) is used for success indicators, as green is widely recognized as a symbol of **confirmation and success**, making it ideal for highlighting completed actions or validated inputs. This carefully designed color scheme ensures that users can quickly interpret application states, enhancing both usability and accessibility.

User interface components, particularly modal popups, have been designed with both **functionality and aesthetics** in mind. These modals feature **semi-transparent backdrops** (`backdropOpacity: 0.5`), ensuring that content remains readable while subtly dimming the background to reduce distraction. The use of **rounded corners** (`borderRadius: normalize(20)`) contributes to a modern and polished appearance, while **shadow effects** (`shadowColor: "#000", shadowOpacity: 0.3`) provide depth and improve visual

hierarchy. Furthermore, **smooth transition animations** (`animationIn: "slideInUp", animationOut: "slideOutDown"`) create a fluid and engaging user experience.

Interactivity is optimized through touchable components that provide immediate feedback upon user actions. Buttons have distinct visual states, and all images are scaled dynamically using `resizeMode: "cover"`, ensuring that they fit seamlessly without distortion.

By integrating these adaptive styling techniques and maintaining a consistent design language, the application achieves an optimal balance between **visual appeal, usability, and performance**, delivering a high-quality user experience across a wide range of devices.

## 7.5 Limitations and Hard-Coded Parts

During the development process, our focus was primarily on design while minimizing backend work. Our configuration includes a library for displaying the map and a separate library for rendering the player's 3D character.

This configuration has certain limitations in rendering the environment, as the terrain color is solid and does not support the application of textures to enhance visual depth. Additionally, 3D modeling of buildings has been disabled to facilitate a 2D map view. If re-enabled, the models would lose their intended effect and appear to be “floating” above the buildings.

Furthermore, there is a limitation on the extent of user interaction with the map. Currently, users can only interact by physically moving their device, without the ability to make finer adjustments to their view of the surroundings. This constraint arises from challenges in achieving smooth and independent synchronization between map movement and the 3D model, which would otherwise result in jittering and misalignment between the user's actual position and the model.

The different game sessions and landmarks are hardcoded in terms of position. While game sessions spawn dynamically near the player when their location is recorded, their respective landmarks remain static. This design constrains the application to operate within a controlled environment with defined geographical boundaries (e.g., within Valentino Park) to allow users to complete a game session. Furthermore, the process of searching for a new game session is also pre-configured to match an existing session. This approach is intended to simulate the system's ability to add new game sessions dynamically during gameplay. However, only one new game session is available for discovery, with no additional sessions accessible.

The “add new landmark” functionality allows users to capture a photo and fill out a form specifying the name and location of the landmark. However, the captured photo does not appear in the application, as this feature is designed to involve an authority figure who asynchronously reviews and approves submissions before incorporating them into new game sessions. While this creates a realistic scenario, the submitted photos will not be displayed in newly generated game sessions.

Lastly, the profile feature is represented as a disabled button that does not open any interface. The application is hardcoded to operate in a state where a user is already logged in, with no functionality for logging in or out.

To maintain responsiveness and efficiency, the application employs **asynchronous storage (AsyncStorage)** for session persistence, preventing data loss and ensuring smooth navigation.

## 8. Usability Testing

### 8.1 Preparation and Run

The final phase of the project involved conducting usability tests with the goal of presenting a stable version of the hi-fi prototype to a group of end users. This allowed us to gather detailed and concrete feedback on how effectively we conveyed the functionalities we had developed up to this stage of the project.

#### 8.1.1 Participants and Testing Setup

The usability tests were conducted with a target group consisting of cyclists and runners aged between 20 and 40 years. The participants had varying levels of familiarity with travel and discovery applications, with only basic knowledge of English terminology and local Turin locations. However, all participants were accustomed to using smartphones and mobile applications on a daily basis. All tests were conducted at Parco del Valentino, where dedicated game sessions were specifically set up. By rotation, each of us took on the role of facilitator and observer at least once.

The **first test** was conducted with *Daniele Bruscia* as the facilitator, *Nicolò Taormina* as the observer, while *Marco Profilo* and *Francesco Gabrieli* took notes and captured photos.

The **second test** was conducted with *Nicolò Taormina* as the facilitator, *Daniele Bruscia* as the observer, with *Marco Profilo* and *Francesco Gabrieli* again responsible for taking notes and capturing photos.

The **third test** was conducted with *Marco Profilo* as the facilitator, *Francesco Gabrieli* as the observer, while *Nicolò Taormina* and *Daniele Bruscia* took notes and captured photos.

The **fourth test** was conducted with *Francesco Gabrieli* as the facilitator, *Marco Profilo* as the observer, while *Nicolò Taormina* and *Daniele Bruscia* took notes and captured photos.

## 8.1.2 Equipment and Technical Requirements

For the tests, the team provided a smartphone to each participant. Additionally, a separate smartphone was used by a team member to record video and audio during the sessions. The testing environment required internet connectivity, enabled localization services, and granted camera permissions to ensure smooth execution.

## 8.1.3 Artifacts and Materials

To facilitate the usability tests, the following materials were prepared and used:

- **List of tasks:** a document specifically designed for participants was prepared, outlining each task that users should be able to accomplish while using the application. Alongside each task, a brief scenario was provided to help participants immerse themselves in the hypothetical role of a researcher utilizing the application in a real-world context. This approach aimed to enhance engagement and ensure a more authentic and insightful usability testing experience. The tasks that were presented are as follows:
  - *Refresh your surrounding to find New Game Session to be played*
  - *Choose a Game Session you may be interested in playing and verify it was added to your list*
  - *Discover a Unique Landmark*
  - *Add a New Landmark portraying a tree to Wanderlust*
  - *Verify you have no more Game Session left in your list*
- **Consent form:** a document representing an informed consent to be presented to the evaluators in the early moments of the test sessions.
- **Pre-test questionnaire** to gather initial insights
- **SUS Survey:** a document containing the **System Usability Scale (SUS)** questionnaire was provided to each participant to complete at the end of the test. This questionnaire consisted of a set of standardized questions designed to offer a quick yet reliable assessment of the system's usability from the tester's perspective. The SUS allowed us to quantitatively evaluate the overall user experience and identify potential areas for improvement based on participant feedback.
- **Pens** for note-taking and questionnaire completion
- **Structured script:** a document was created to explicitly outline the flow of the test session from the facilitators' perspective. It was structured as a near word-for-word script, detailing exactly what facilitators were expected to say, along with specific instructions on how to manage the various documents used during the session. The primary purpose of this script was to ensure consistency in the interaction with all evaluators, preventing variations in the information provided or differences in how the test structure was presented. By standardizing the facilitators' approach, the document helped minimize potential biases, ensuring that all participants experienced the usability test under the same conditions for more reliable and comparable results.

## 8.2 Results

For each task, we assessed both user feedback and predefined evaluation criteria. The plan of the usability test can be found inside the [A5 folder](#). Upon completion of the test, participants were asked to fill out the SUS (System Usability Scale) questionnaire, followed by a verbal discussion with the facilitator. This discussion aimed to dynamically identify concerns and pain points, providing deeper insights into user interactions and challenges while using the application.

### 8.2.1 Quantitative Results

We began by analyzing each task to determine whether participants encountered any critical or non-critical errors. The results were categorized as follows:

- **Complete with Success:** The user successfully completed the task without any errors.
- **Success with Minor Issue:** The user completed the task but encountered at least one non-critical error.
- **Failure:** The user encountered a critical error that prevented them from completing the task.

Task Measurement of Success										
Task		Complete with Success			Success with Minor Issue			Failure		
#	# of Participant	#	%	Confidence Interval(*)	#	%	Confidence Interval(*)	#	%	Confidence Interval(*)
1	4	2	50	(15, 85)	2	50	(15, 85)	0	0	(0, 46)
2	4	3	75	(29, 97)	1	25	(3, 71)	0	0	(0, 46)
3	4	4	100	(54, 100)	0	0	(0, 46)	0	0	(0, 46)
4	4	4	100	(54, 100)	0	0	(0, 46)	0	0	(0, 46)
5	4	4	100	(54, 100)	0	0	(0, 46)	0	0	(0, 46)
6	4	3	75	(29, 97)	1	25	(3, 71)	0	0	(0, 46)

(\*)The confidence interval is displayed as percentages and is calculated using the [adjusted Wald interval](#) with a confidence Level of 95% to compensate for the small sample size used during the Usability testing.

All of our participants never experienced a failure during the test, providing a clue that, for our small participant number, the application was working, providing a correct response to the user. Extrapolation of our data is important, and for that reason, we used the adjusted Wald interval to predict a confidence interval (also performed for the other category) in which a failure can occur.

Our measurement also shows a few successes with minor issues that, compared to the success without any failures, further highlight the solid design decisions and decision-making throughout the project's development.

After each test, we asked participants to take a moment to evaluate the task assigned to them with a simple scale of difficulty, helping us identify which parts of the application might present more challenges than others. This measurement, combined with the **"Task Measurement of Success"**, allows us to assess the perceived difficulty of a task without solely relying on the objective of completing it.

Single Ease Question (SEQ)						
Participant	Q1	Q2	Q3	Q4	Q5	Q6
1	7	6	4	5	7	3
2	6	7	4	6	7	1
3	4	3	2	3	1	3
4	7	7	4	7	7	7
Average	6	5.75	3.5	5.25	5.5	3.5

For each question, the difficulty scale ranges from 1 (very difficult) to 7 (very easy), with intermediate values representing increasing levels of ease: 2 (difficult), 3 (somewhat difficult), 4 (neutral/moderate), 5 (somewhat easy), and 6 (easy).

This questionnaire indicates perceptive results in terms of problem areas of the application, namely in performing a Game Session, verifying remaining games in the list, and removing any remaining items. Task 3 in particular indicates there to be a problem in playing a game, and Task 6 indicates there to be a problem in understanding the concept of a list of games. The problem is caused by a mistranslation of the participant's description of their respective mother tongue's task, possibly causing vagueness in initially presented English tasks. Insufficient visual perception of particular details in the interface also possibly contributed to these issues.

The SUS questionnaire is a quick and simple way to get a general understanding of how an application performs. However, it does not provide insights into its strengths and weaknesses. This questionnaire was used to complement other metrics rather than being relied upon exclusively.

System Usability Scale (SUS)											
Participant #	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	SUS Score
1	3	2	3	3	3	3	4	3	2	3	52.5
2	3	3	4	3	4	2	4	2	2	2	65
3	4	4	2	1	2	2	3	3	4	1	60
4	3	3	3	4	3	3	4	2	4	4	52.5

On average, the SUS score 57,5 for the 4 participants, showing an *average score* for the usability of the application.

This result means that there is neither a highly flawed design nor a highly efficient one in the project. It is a standard application that has design decisions that adhere to applications that already exist, providing a familiar initial impression to users. Neither is it highly disorienting to users, though, nor is it highly intuitive in that it requires users to hesitate momentarily before acting.

## 8.2.2 Qualitative Results

The prototype testing provided valuable insights into both the strengths and areas for improvement in the application. Participants engaged with the system, completing various tasks while providing qualitative feedback on usability and functionality.

### 8.2.2.1 Successful Tasks

- **Understanding the Application's Core Concept:** Participants understood the general idea of the game and its progression mechanics.
- **Accepting and Completing a Game Session:** Users were able to select and play a session successfully.
- **Adding a Landmark:** The process of adding a new landmark was intuitive, and users completed it without difficulty.
- **Unlocking Next Steps:** Testers understood that progressing required approaching the reference point.
- **Game Mechanics Recognition:** Users correctly identified that progressing through the game required interaction with specific landmarks and that the system recognized proximity to objectives.

### **8.2.2.2 Pain Points and Challenges**

#### **1. Difficulty in Locating Points of Interest (Landmarks)**

- The primary issue encountered was the lack of clarity regarding landmark locations.
- Some landmarks, such as the “*Fisherman*” in the Valentino Park, were particularly hard to find due to their hidden placement.

#### **2. Riddles Alone Are Not Sufficient for Navigation**

- Users unfamiliar with Valentino Park found the riddles insufficient for pinpointing locations.

#### **3. Understanding Certain Features Was Not Intuitive**

- Some interface elements, such as retrieving game sessions and checking for landmark additions, are confusing because you can't review the landmarks a person adds.

#### **4. Confusion Regarding Game Completion**

- Some users were unsure whether they had completed a session or if there was more to do.
- The unique landmark task was often misunderstood as a mandatory step rather than an optional extra challenge.

#### **5. Challenge Timer Misinterpretation**

- Many users mistakenly believed that the game had a time limit due to the timer associated with the challenges.

#### **6. Lack of Visibility for Help Features**

- The “*Info*” button, which explained key UI elements, was overlooked by users.

### 8.2.3 Photos and Captions





#### 8.2.4 Key Learnings

From the prototype and usability testing, several key insights emerged.

Participants primarily used smartphones and laptops and were generally comfortable with navigation apps like Google Maps.

However, they expected a more direct and intuitive way to take and utilize photos when adding landmarks.

Some users found it unclear when a session was fully completed, leading to confusion about whether they should continue playing.

While certain participants could easily identify landmarks, others struggled, especially with less visible or less distinctive locations.

Additionally, some buttons were misinterpreted, particularly those related to game sessions and available interactions.

A common issue was that many users assumed optional challenges were mandatory, resulting in unnecessary frustration.

These findings highlight areas where the usability and user experience could be improved.

## 8.2.5 Proposed Changes and Justifications

One of the primary improvements needed in the application is **enhancing landmark navigation** by adding **directional hints**. Several users, particularly those unfamiliar with the location, struggled to locate landmarks, especially when they were hidden or not immediately visible. This issue became more apparent during testing, as some participants expressed frustration over the time required to find landmarks and the difficulty of deciphering riddles.

Currently, the application features a **world view controlled by a near-camera positioned behind the user**, which helps maintain immersion but presents challenges in **interpreting the surrounding environment**. A critical limitation is the **background color settings of the map**, which restrict visual differentiation between various terrain elements. This is particularly problematic when riddles provide **directional hints based on map reference points** (e.g., "You will find it near the Po River").

Another critical improvement involves **clarifying the game session completion status**. Some users expressed uncertainty about whether they had finished a session or if there were additional steps to complete. To eliminate this confusion, the application could display a **clear message** at the end of each game session, explicitly stating, suggested by a participant:

*"Game Session Completed! Would you like to continue with extra challenges?"*

This would provide users with an **explicit signal** that they have successfully completed the session, while also giving them the option to continue exploring.

Additionally, **some users struggled to retrieve active sessions and verify completed ones**. This issue could be addressed by **refining the interface with clearer button labels and improved navigation paths**, making it more intuitive for users to manage their progress.

### 8.2.5.1 Trivial Solutions

Some improvements can be implemented with minimal effort to **enhance usability without introducing major structural changes**:

- **Fixing grammatical errors** and improving the wording of riddles to prevent misunderstandings and reduce user frustration.
- **Camera Angle Optimization**: Further testing should be conducted to determine an **optimal camera angle** that maximizes the **field of view** while keeping the **local position clearly visible**.
- **Enhancing the Help & Info Section**: Users frequently ignored the existing "**Info**" **button**, either because it was not prominent enough or because they assumed they did not need additional guidance. This issue could be resolved by:
  - **Making the button more visually accessible** through a more noticeable design.
  - **Incorporating a short guided tutorial at first use** to ensure users fully understand how to navigate and utilize the application's features.

- **Refining the Landmark Addition Process:** Users found it difficult to understand how to add landmarks, particularly when using photos. A simple fix would be **allowing users to tap anywhere in the container where the camera icon is present**, rather than requiring them to press the small "+" button.

### 8.2.5.2 Non-Trivial Solutions

Some underlying issues require more complex modifications that go beyond simple UI adjustments:

- **Clarifying the Challenge Timer:** Many users mistakenly believed that the entire game was time-limited, causing unnecessary stress. To fix this, when the timer appears, a **short explanatory popup** should state that it is only associated with the **extra challenge mode** and does not apply to the entire game session. This popup could include a "Don't show again" option for better usability.
- **Difficulty Adjustment Mechanism:** A system that **dynamically adapts difficulty based on user performance** would enhance accessibility and engagement, allowing users to progress at their own pace. One way to implement this is by **integrating directional cues**, such as **approximate distances and indicators**, to help users navigate toward their objectives more effectively. By tailoring navigation assistance to individual user needs, the system can **ensure a smoother and more intuitive exploration experience**, reducing frustration and improving overall usability.
- **Mapping Library Limitations:** The current development framework (*react-native-maps*) only supports **solid colors** for various map elements (e.g., roads, walkways, landscapes). This constraint **hinders visual clarity**, making it harder for users to **distinguish landmarks from their surroundings**. Additionally, implementing **3D-modeled buildings** would disrupt the **visual consistency of the 3D player model** within the map.
- **Alternative Mapping Libraries:** A potential long-term solution would be adopting a **different mapping library** that supports:
  1. **3D player markers** for better orientation.
  2. **More diverse map features**, allowing for richer environmental differentiation.

By addressing both **trivial and non-trivial issues**, the application can **significantly improve the overall user experience**, making **landmark exploration, game session management, and navigation** more intuitive while maintaining visual and functional consistency.

# 9. Conclusions

## 9.1 Main Learnings

Throughout this semester, we have gained valuable insights into the process of designing and developing a user-centered application. We tackled the many challenges of this field, from understanding user needs to testing, experiencing firsthand the importance of an iterative, feedback-driven approach.

A crucial part of our **project** was the initial research phase, where we conducted user interviews to better understand their needs and expectations. This step proved essential in defining solid system requirements. We then used **Figma** to create wireframes and interactive medium-fi prototypes, allowing us to iterate quickly on the design before moving to development.

On the technical side, we implemented our high-fi prototype using **React Native**, which enabled us to develop a cross-platform application while maintaining a shared and efficient codebase. During development, we consistently applied usability and accessibility principles, ensuring a smooth and intuitive user experience.

Finally, the testing phase reinforced how essential it is to validate design assumptions through direct user interaction. The tests helped us identify navigation flaws and refine the user experience, highlighting the importance of the continuous cycle of design, development, and validation.

Beyond deepening our knowledge of human-computer interaction theories, our **project** has given us the opportunity to develop concrete practical skills, making us more aware and adaptable in designing effective digital experiences. Our journey has shown us that good design is not just about aesthetics, but the result of a rigorous, user-centered process driven by real data and iterative testing.

## 9.2 Group Feedback

In this project, we all worked fairly and collaboratively, ensuring equal contribution across different phases. Initially, during the interview stage, we took turns performing the roles of interviewer, recorder, and photographer. Later, we worked together to extract *user needs*, *deep needs*, and to define the *final solution*.

Regarding the **Storyboard**, Daniele Bruscia took charge of its creation due to his artistic skills.

For the **first prototype (Smartphone + Touch)**, which was ultimately developed and carried forward, **Marco Profilo** and **Daniele Bruscia** were responsible. Meanwhile, the **second prototype (Smartwatch + Touch)** was handled by **Nicolò Taormina** and **Francesco Gabrieli**. During the **Medium-Fidelity prototype phase** in Figma, all team members collaborated, each contributing to the design and development of different pages.

For the **High-Fidelity prototype**, implemented with **React Native and Expo**:

- Nicolò Taormina developed the *map* and the *3D model* of the user (cyclist).
- Daniele Bruscia was responsible for creating the buttons for the *list of accepted Game Sessions*, updating and searching for *new Game Sessions nearby* (*both graphic and functionalities*), and designing the *landmark addition button* (*graphic only*). He also added an *info button* explaining the function of the three buttons mentioned above on the main screen and implemented the *experience progression system*, which increases upon achieving a success and the preloaded screen used to allow the system to fully load the 3d model.
- Marco Profilo worked on the *Landmark pop-ups*, the *unique Landmark feature*, and the *final screen* marking the *completion* of a Game Session.
- Francesco Gabrieli implemented the pop-up for *adding a new landmark* (*complex task*).

We collaborated as a team on the overall UI design, ensuring a consistent and polished visual identity across **pop-ups, buttons, and interactive elements**, focusing on both aesthetics and usability to enhance the user experience.

Finally, during the **usability testing phase**, each of us took turns playing the roles of Facilitator and Observer, ensuring a well-rounded evaluation process.

Of course, there were some differences of opinion within the group, particularly during the design phase of the high-fidelity prototype. However, all disagreements were promptly addressed and resolved, ensuring that they did not hinder the development process in any way.